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ASD TECHNICAL REPORT 62-7-510

AUGUST 1962

DEVELOPMENT OF A HIGH TEMPERATURE SEALED WIRE WOUND VARIABLE RESISTOR

JAMES A. FRED

MALLORY CONTROLS COMPANY

FRANKFORT, INDIANA

CONTRACT AF33(600)37951

ASD PROJECT: 7-510

FINAL TECHNICAL ENGINEERING REPORT

OCTOBER 1958 - AUGUST 1962

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ELECTRONICS BRANCH

MANUFACTURING TECHNOLOGY LABORATORY

AFSC AERONAUTICAL SYSTEMS DIVISION

UNITED STATES AIR FORCE

WRIGHT-PATTERSON AIR FORCE BASE, OHIO

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ASD TR 62-7-510

ASTIA Document NR:

ASD Technical Report 62-7-510

August 1962

(Unclassified)

Development of a High Temperature Sealed Wire Wound Variable Resistor

James A. Fred, Engineer

Mallory Controls Company
Div. of P. R. Mallory & Co., Inc.
Frankfort, Indiana

Contract AF33(600)37951
ASD Project: 7-510
October 1958 - August 1962

Electronics Branch
Manufacturing Technology Laboratory

FORWARD

This Final Technical Engineering Report covers all work done under Contract AF33(600)-37951 from October 18, 1958 to March 6, 1962. The manuscript was released by the author in August 1962 for publication as an ASD Technical Report

This contract with the P. R. Mallory & Company, Incorporated, Indianapolis, Indiana, was initiated under ASD Manufacturing Methods Project 7-510, "Development of a High Temperature Sealed Wire Wound Variable Resistor". It was accomplished under the technical direction of Mr. Harold K. Trinkle of the Electronics Branch (ASRCTE), Manufacturing Technology Laboratory, Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio.

Mr. David G. Williams, Project Engineer, and Mr. James A. Fred, Development Engineer, were the engineers in charge. Others contributing to the work performed during the program were Mr. James Ayres, Process Engineer, and Mr. Robert L. Frey, Development Engineer.

This project has been carried out as a part of the Air Force Manufacturing Methods Program. The primary objective of the Air Force Manufacturing Methods Program is to develop on a timely basis manufacturing processes, techniques, and equipment for use in economical production of USAF materials and components. The program encompasses the following technical areas:

Rolled Sheets, Forgings, Extrusions, Castings, Fiber and Powder Metallurgy Component Fabrication, Joining, Forming, Materials Removal
Fuels, Lubricants, Ceramics, Graphites, Non-metallic Structural Materials Solid State Devices, Passive Devices, Thermionic Devices.

Your comments are solicited on the potential utilization of the information contained herein as applied to your present or future production programs. Suggestions concerning additional Manufacturing Methods development required on this or other subjects will be appreciated.

* * * * * * * * * * * * *

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:

JACK R. MARSH
Assistant Chief
Manufacturing Technology Laboratory
Directorate of Materials & Processes

Abstract-Summary | ASD Technical Report 62-7-510

Final Technical Engineering Report | August 1962

Variable Wirewound, High Temperature, Sealed Resistor

James A. Fred

Mallory Controls Company

Div. P. R. Mallory & Co., Inc.

Hermetically sealed variable wirewound resistors can be manufactured using the equipment and processes described in the complete report.

The design of the sealed variable wound resistor provides that the completed resistor will be insensitive to most environments.

Finished units are able to withstand such tests as torque, temperature cycling, high temperature exposure, load life, salt spray corrosion, moisture resistance, insulation resistance, low temperature storage, acceleration, shock, and vibration. The only unsatisfactory feature of this variable resistor was its inability to pass the rotational life test in the higher resistance values wound with .001 inch diameter wire. A satisfactory solution was never found to this difficulty.

Most of the equipment used to make these sealed variable resistors was of standard commercial design with special jigs and fixtures attached where needed.

Detailed drawings, processing data, descriptions, and drawings (where necessary) of all production equipment, floor space requirements, and a recommended layout of all equipment will be specified in the complete report to AFSC-ASD (ASRCTE) Wright-Patterson Air Force Base, Ohio.

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INTRODUCTION

The following report represents the results of work done to develop a high temperature, sealed, wirewound, variable resistor.

This contract was divided into four distinct phases.

PHASE I provided for: a study of the state-of-the-art, an evaluation of materials, design techniques, and processes outlined in various government publications, production processes and techniques, and an approximate cost per resistor. This phase was successfully completed.

PHASE II provided for: establishment of pilot lines, pre-production samples to be built and tested and for copies of test results to be published and distributed. This phase was partially successful.

PHASE III provided for: a quantity of resistors to be produced on tools and fixtures provided by the contractor; also for inspection and testing procedures to assure adequate quality production. No action was taken on this phase.

PHASE IV provided for: the final technical engineering report.

The following report describes this effort in detail and includes both our successes and failures while working on this contract.

I. THE DESIGN AND DEVELOPMENT OF A HIGH TEMPERATURE SEALED WIREWOUND VARIABLE RESISTOR

A. Design Philosophy

The contract which this report is concerned with provided for the development of a wirewound, high temperature, sealed variable resistor. The final version was to consist of a cast brass outer case, a 3/4 inch diameter wirewound variable resistor inserted into the outer case, and a heavy brass cover was to be soldered in place. Hermetic sealing would be aided by the use of a high temperature "O" ring shaft seals and glass sealed terminals.

The reason for choosing the indicated materials for use in fabricating the internal parts of the variable resistor are detailed as follows:

1. Wire

Previous experience in the manufacture of wirewound variable resistors indicated that either Evanohm or Cupron or their equivalents would be the most desirable in a resistor of this type. It was felt that these wires were desirable because of their low temperature coefficient and its high resistance of 800 ohms per circular mil foot. However, it was necessary to use an Alloy wire on resistance values under 50 ohms because the wire size would have been too big to be practical with Evanohm or Cupron.

2. Insulating Materials

An investigation of high temperature insulating materials included asbestos, Quinterra board, anodized aluminum, fiberglass, Teflon, and silicone glass laminates. The silicone glass laminates were found to be satisfactory in all respects. Manufacturers were found who would guarantee that their silicone glass laminates would operate continuously at 250°C. The core strip has to be made of material sheared at a 45° angle to provide the necessary flexibility to enable it to be formed inside the small diameter cup used.

3. Contact Devices

Various materials such as carbon steel, spring brass, beryllium copper, alkaloy, and nickel silver were considered for use as contact arms. Nickel silver alloy, number "2" hard temper, showed the least amount of relaxation after exposure to a temperature of 200°C for 1,000 hours. A later investigation showed that this material could be improved even more by a twelve (12) hour heat treatment at 250°C.

4. Shafts

Three materials, stainless steel, cold rolled steel, and brass were considered for shafts. Two of the materials were suitably plated to withstand the salt spray test.

4. Shafts

Passivated stainless steel proved to be outstanding in this application. Another consideration besides the salt spray test was the stop torque test. With three turn-downs in the shaft for "O" rings, all materials except stainless steel twisted apart before the desired stop torque was reached.

5. Hermetic Shaft Seals

Several types of hermetic shaft seals were discussed. Experiments were conducted using beryllium copper bellows, Teflon shaft seals, metal to metal seals, graphitar seals, and silastic rubber "O" rings. The "O" rings proved out to be the simplest and easiest to use in manufacturing and gave satisfactory results in testing.

6. Inner Case, Cover, and Terminals

It was decided to make the inner case a zinc diecasting. This design would provide a case, locating lug, sealing gland, and threaded mounting bushing in one unit. It was felt that the intricacies of the case did not make it feasible to use a machined or stamped part. The cover was to be made of brass while the terminals were to be made of cartridge brass. These parts will have a final gold plating over nickel.

7. Outer Case and Cover

The outer case and cover will be of brass, made by Investment Casting, buffed, nickel, and gold plated. It was felt that since this resistor could be exposed to a corrosive atmosphere, gold would give the best protection.

B. Finalized Design

The materials and finishes proposed in the previous section were used to build a total of 160 variable resistors for the Phase II preproduction test program. Many of the proposed designs proved to be quite satisfactory while several other problem areas were never successfully overcome. Areas where satisfactory results were partially attained are listed as follows:

1. The inner die case case was a source of constant irritation. The case was originally tooled up as a short run die. The history of this part indicates that the die casting started off with all the critical dimensions within print but soon many dimensions began to fall out of the print tolerance. After several discussions with the vendor, the die was returned and after examination it was decided that it should be re-tooled. Subsequently, it was tooled with the Dowst Manufacturing Company, Chicago, Illinois. This vendor soon was in trouble. First with the depth of the case, which he corrected by building a trim die. Next excessive flash was found in the window that the terminals extended through.

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1. Cont'd.

Also troublesome were pits, blow holes, and cold flow in the die cast material. Especially bad were pits and blow holes in the threaded area of the bushing. This resulted in two faults which could not be corrected without scrapping the cases. The holes in the bushing prevented hermetic sealing, because since the threaded portion extended through the outer cover air or liquid could enter into the inside of the control. In addition pits and blow holes in the ID of the bushing left a rough surface for the "O" rings to rotate against. The next result was that the "O" ring would be chewed up after only a few shaft rotations. The vendor was never able to completely eliminate pits and blow holes in the bushings. What good parts we had to use were detailed from a large number of parts.

2. Another source of early trouble in the program was the gold plating. The gold plating would flake off when the variable resistor was subjected to an elevated temperature of 200°C or higher. A test was developed that allowed the sorting out of the good plating from the bad. This test consisted of subjecting the plated cases to a temperature of 300°C for one hour. If the cases came through this test without the plating blistering, pitting, or flaking, then the case would be satisfactory for production use. Pursuing this matter further, the plating process was examined; and while no particular flaw could be found causing this type reject,

2. Cont'd

it was decided to have the plating done by a different vendor. The new vendor, PRECISION ELECTRO-PLATING COMPANY, Chicago, Illinois was able to pass the 300°C test satisfactorily without rejects.

3. Another difficulty was the improper clinching of the ears on the cover and the failure of the clinching ears to hold the cover engaged to the inner case. While it was felt during the original design work that sufficient material was provided, it was found that more material had to be provided. The tools were reworked to increase the length of the clinching ears which solved the problem.

4. Hand soldering of the cover to the outer case was very difficult so it was decided to use a newly purchased induction heater with the proper work coil to do the soldering. A silastic "O" ring under the outer cover is used to provide for release of heated expanded air during the soldering. After the case is cooled, a nut is drawn down on the cover which completes the seal between the inner and outer cases.

5. Several lubricants were tested for lubricating the shaft, "O" ring, ground ring, coil, and rear bearing. Because of the extreme operating temperature range, -55°C to 250°C, it was found that a Dow Corning compound DC-11 would be the most satisfactory.

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6. The insulator strip that is used to insulate the wound core strip from the die cast case gave some trouble. The .010 inch thick silicone glass material had an advertised voltage breakdown of 400 volts DC per mil thickness. This would indicate that a strip .010 inches thick would withstand 4000 volts DC. The strips we were receiving were breaking down between 1800 and 2600 volts DC. After trying several vendors, we were able to find one, MICA INSULATOR COMPANY, whose silicone glass material would pass this test.

7. Several problems were encountered with the winding and assembling of the resistance winding.

7.1 Problem number one concerned the core strip upon which the wire was wound. This is a strip of silicone glass approximately .030 inches thick by two inches long, by .625 inches wide with a radius on the top and bottom of the strip. To facilitate forming this strip the material must be cut on a 45° angle from the direction of the weave. The strips thus cut varied in length from over four feet to one foot after which they are again cut to various length at our plant, depending on the wire diameter to be wound on the strips, to fit the die cast case. The silicone glass is very abrasive so that the cutting tool must be kept sharp at all times. Another difficulty is the cutting of a notch at each end of the core strip to anchor the end

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7.1 Cont'd

turns of the winding. The notch needs to be a tight fit for .001 inch diameter wire but must also permit larger wire sizes to be inserted into the notch as well.

7.2 Another problem was that of silvering the ends of the winding. Due to the small size of the assembly, it was found necessary to apply the silver short out under a strong magnifying glass. The silver must cover the ends of the wire completely but still not be spattered on the 1/16 inch barrier left between the end of the wire and the end of the core strip. The desired effect was finally achieved by careful workmanship.

7.3 It was thought that an improvement could be made if the wire was cemented down to the core strip on the back side. A Dow Corning composition called Silastic 140 adhesive was tried but was not satisfactory. Several silicone compounds were also tried but with limited success. This is more fully explained in the section under pre-production testing.

7.4 Another area investigated was the use of grooved core strip and a thinner, .020, core strip. The grooved core strip formed much better in the resistor case but proved to have other drawbacks. Many experimental wound strips were made with the grooved strips. Extreme difficulty was

7.4 Cont'd

experienced in grooving the silicone glass so a thinner strip was tried. It was quite difficult to get a satisfactory radius on the edges of this strip. The result was that whenever .001 diameter wire was used it always broke when it went over the edges. Precoating the .020 thick silicone glass core strip was tried but was never perfected. There will be a further discussion on this problem in the section relating to preproduction testing.

RESULTS OF FIRST PRE-PRODUCTION TEST

Forty variable resistors each of three ohms and 25,000 ohms were assembled and subjected to the tests specified by Exhibit WCRE 56-71. A copy of the exhibit appears in the appendix.

The resistors passed the following tests:

1. Mechanical and visual inspection (4.3).
2. Resistance (4.4).
3. Insulation resistance (4.8).
4. Dielectric test at atmospheric pressure (4.9.1).
5. High temperature exposure (4.12).
6. Stop torque (4.10.2).
7. Low temperature storage (4.13).
8. Acceleration (4.20).
9. Shock (4.21).
10. Vibration (high frequency) (4.19).

The resistors failed the following tests:

1. Dielectric test at reduced atmospheric pressure (4.9.2).

   1.1 All of eighty resistors failed to pass this test because the voltage arced over the hermetic terminals.

   1.2 After checking with the manufacturer of the hermetic terminals, it was determined that the terminals were not meant to withstand a sine wave potential of 550 volts RMS at a reduced pressure of 2.1 inches of mercury (absolute).

1.3 A change in specifications was requested for this requirement.

2. Rotational torque (4.10.1)

2.1 Forty out of eighty variable resistors failed to pass the 1.5 inch ounce minimum torque specified.

2.2 A change in specifications was requested for this requirement.

3. Temperature cycling (4.11).

3.1 Thirty-four out of eighty variable resistors exceeded the 1 per cent permanent change in resistance allowed by the specification. A change in the type resistance wire used was to be considered as well as asking for a change in the specification for this requirement.

4. Low temperature exposure (4.13)

4.1 Eight out of eighty resistors exceeded the 15 inch ounce limit on torque specified after one hour at -65°C.

4.2 Thirteen out of eighty resistors were open or intermittent at the end of the low temperature cycle.

4.3 Since the torque at room temperature was too low and the grease used to lubricate the shaft was the best known available lubricant, it was decided to ask for a change in specifications.

5. 1000 hour load life (4.14)

5.1 Seventeen out of twenty resistors tested exceeded the 1 per cent change in resistance allowed by the specification.

5.2 It was decided that different types of wire should be investigated to see whether or not this condition could be improved.

6. Salt spray corrosion (4.15).

6.1 All twenty resistors tested showed signs of corrosion.

6.2 This corrosion was not considered detrimental to the operation of the variable resistors.

7. Moisture resistance (4.16)

7.1 Sixteen of the twenty resistors exceeded the 1 per cent change in resistance allowed by the specification.

7.2 A change in wire type was to be investigated.

8. Rotational life (4.17)

8.1 Seventeen out of twenty variable resistors failed during this test.

8.2 Since these resistors were hermetically sealed, it was not possible to accurately determine what caused the failure. It was assumed that the wire had worn through and that less contact pressure would affect an improvement.

RESULTS OF SECOND PRE-PRODUCTION TEST

As a result of so many failures during the first pre-production test a conference was held between Mallory and government representatives. It was decided that Mallory would re-write the specification using the best available information that would provide for good variable resistors. A copy of this specification is found in the appendix.

After the specification was accepted by both interested parties, forty samples each of 10 ohm and 20,000 ohm variable resistors were assembled and subjected to pre-production testing. The resistors passed the following tests:

1. Mechanical and visual inspection (4.3)
2. Total resistance (4.4)
3. Minimum resistance (4.6)
4. Insulation resistance (4.7)
5. Dielectric strength (4.8)
6. Rotational torque (4.9.1)
7. Temperature cycling (4.10)
8. Salt spray corrosion (4.14)
9. Moisture resistance (4.15)
10. Low temperature storage (4.17)
11. Vibration (high frequency) (4.18)
12. Acceleration (4.19)
13. Shock (4.20)

As you can see, a change in some of the specifications allowed the variable resistors to pass more of the tests than had passed during the previous test program. There were still many categories of failures that were either the same as before or in different tests. The variable resistors failed during the following tests:

1. Resistance Taper (4.5)

   1.1 Three out of forty of the ten ohm resistors failed to pass at the 30 per cent rotation point.

   1.2 Twenty-nine out of forty of the 20,000 ohm resistors failed to pass at the 30 per cent rotation point.

   1.3 One out of forty 20,000 ohm resistors failed to pass at the 50 per cent rotation point.

   1.4 Eight out of forty 20,000 ohm resistors failed to pass at the 100 per cent rotation point.

2. High temperature exposure (4.11)

   2.1 Two out of forty 20,000 ohm resistors exceeded the 5 per cent change allowed in overall resistance.

3. Stop torque (4.9.2)

   3.1 Three resistors out of eighty failed to pass the six inch pound stop torque test.

4. Low temperature exposure (4.12)

   4.1 Seven resistors out of eighty exceeded the eighteen inch ounce limit.

5. Load life (4.13)

   5.1 Two resistors out of ten 20,000 ohm resistors exceeded

the 5 per cent change allowed in overall resistance.

6. Dielectric strength after rotational life (4.16.2)

   6.1 One 10 ohm resistor failed to pass this test.

7. Rotational life (4.16)

   7.1 Four out of ten 10 ohm resistors failed to pass this test.

   7.2 Ten out of ten 20,000 ohm resistors failed to pass this test.

Most of the failures could be easily explained and more care in manufacturing would result in getting all good resistors. However, the rotational life test was so dismal that a development program was started to see whether or not resistors could be made that would pass the rotational life test. Items to be investigated were as follows:

1. Various types of lubricants were to be tried on the wire.
2. The length of the core strip was to be adjusted so that the coil would be formed into a true radius when pushed into the cup.
3. The optimum contact pressure was to be determined.
4. An attempt would be made to reduce the wear on the ground ring.
5. An attempt would be made to apply a silicone resin to the wire after it was wound on the core strip. The reason that this was done was because it is common practice in the variable wirewound industry to cement the wires to the core strip. It was felt that this was one reason why the

wires broke during the rotational life test.

6. The use of thinner core strip material was to be investigaged. It should be pointed out that the rotational life problem primarily concerned the 20,000 ohm variable resistor which is wound with .001 inch diameter nichrome wire. The following discussion relates only to this resistance value.

A discussion of the work done on each of these items follows:

1. Some lubricants obtained were Cosmolube 615, Dow Corning DC5, DC6, and DC11. After several tests, it was decided that DC11 had the best all around characteristics for this purpose. Uses for this lubricant include rear bearing, shaft, "O" rings, and bushing, and wire. It has excellent high and low temperature characteristics.
2. Much work was done on getting the coil to fit into the cup in a true radius. It was finally determined that the tolerance on the cup would make it difficult to always get a good fit. Since we were already in trouble with the cup vendor, we decided to do all our work on the length of the core strip. A satisfactory compromise was then made.
3. The optimum contact pressure was experimentally determined to be 25 grams, so a limit of 20 to 30 grams was decided on for production use.
4. The pressure on the ground ring was reduced by moving

the "C" ring out .005 inches on the shaft. This seemed to give a satisfactory wear pattern to the ground ring.

5. Work was carried on intermittently for two months to try and find a satisfactory way to coat the wirewound core with a silicone resin. At least five different silicone formulations were tried. Three different methods of application were tried. These were painting it on with a paint brush, dipping the strip, and spraying the silicone resin. A satisfactory coating was obtained, and it was determined that a two mil coating on the back of the winding and on the lower half of the front of the winding would best hold the wire in place. The strip was sprayed on one side and air dried. The area where the contact arm ran was masked off and the coating sprayed on and air dried. The wire was then wound on the strip and baked to completely cure the resin. This process was difficult to control and a satisfactory coil was obtained only part of the time. The few good coils that were run on rotational life were completely successful.

6. The use of thinner core strip material was investigated. The only advantage was the ease with which it could be formed into the cup. The drawbacks to the thinner core strip made it difficult to use. Being only .020

inches thick, it was hard to get a smooth radius on the edges. A fiberglass wheel was used to polish this edge but still the wire would break on many coils where it went over the edges. During this period of experimentation, the thin core strip could show no advantage over the grooved thicker core strip.

Even with the improvements outlined above, 100 per cent reliability could never be attained. On one trial run complete success might be attained while on the next trial run all the resistors might turn out to be failures.

It was felt that our process could not be considered a success if we could not get repeatable results. For this reason we never completely solved the rotational life problem on the 20,000 ohm variable resistors.

APPENDIX

EXHIBIT WCRE 56-71
18 OCTOBER 1956
AS AMENDED 10 DECEMBER 1956
PR NR PB-8-MMP-6015

1. SCOPE

1.1 General - These requirements cover a variable wire-wound sealed resistor of the high temperature type, for use in electronic equipment. These requirements relate to a 2 watt, 3 to 25,000 ohms with a tolerance of 10 per cent suitable for continuous operation at temperatures from 65°C to +225°C hot spot. Except for the shaft mechanical drive, all terminations to the variable resistors shall be hermetically sealed. The shaft seal shall be adequate for the resistor to satisfy all requirements of this exhibit.

2. APPLICABLE PUBLICATIONS

2.1 The following publications of the issue in effect on date of the invitation for bids shall form a part of this exhibit to the extent specified herein.

STANDARDS

MILITARY

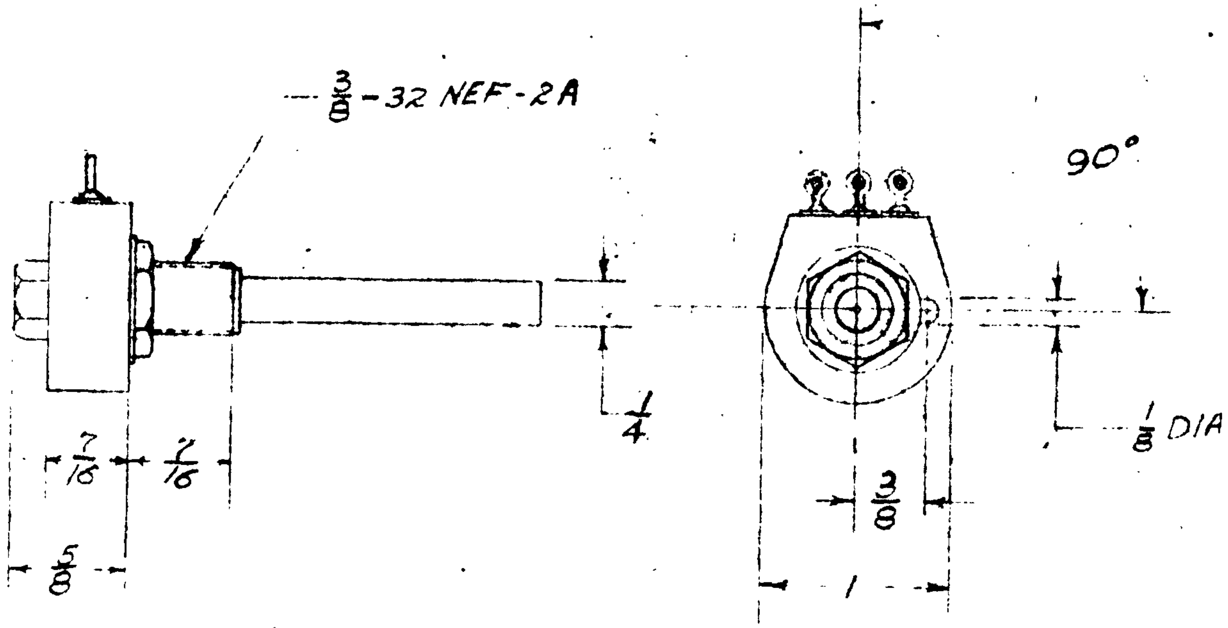
MIL-STD-202 Test Methods for Electronic and Electric Component Parts

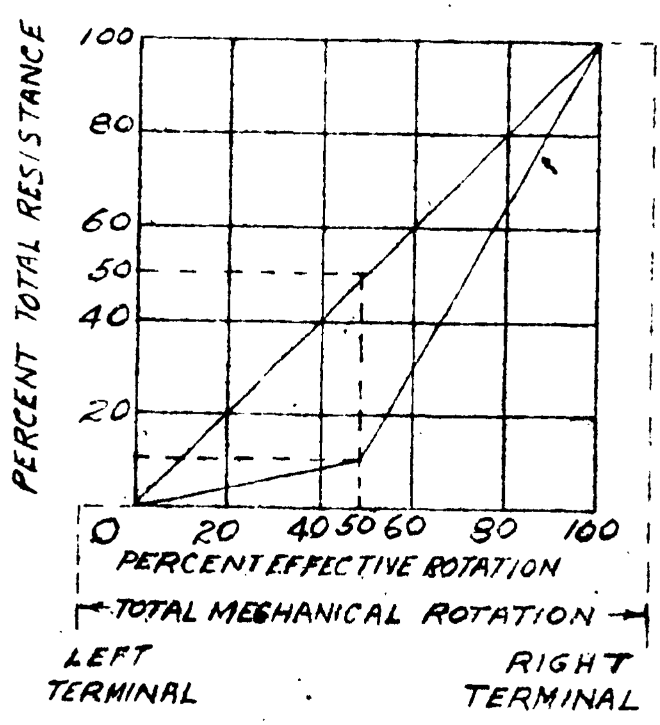
3. REQUIREMENTS

3.1 The requirements of this exhibit are detailed only to the extent considered necessary to obtain the desired objectives. The design, construction and assembly techniques of the variable wirewound sealed resistors shall be such as to facilitate quantity production reproducibility at reasonable cost. The material and mechanical assembly used in the construction of the resistors but not specified in detail shall be of the quality consistent with the proposed and specified performance of the article. Resistors shall be manufactured and processed in a careful and workmanlike manner in accordance with good design and practice.

3.2 Preproduction Samples - Forty (40) of the three ohm resistors and forty (40) of the 25,000 ohm resistors shall be subjected to the tests outlined in Table I by the manufacturer and shall have satisfactorily met the requirements of this exhibit prior to delivery of the resistors called for in the contract.

3.3 Test Data - Test data covering the preproduction samples submitted to the tests of Table I shall be approved by the Government prior to delivery of the resistors called for in the contract.


3/8-32 NEF-2A
90°
1/4
1/8 DIA.
7/16
7/16
5/8
3/8
1


PERCENT TOTAL RESISTANCE
100
80
60
50
40
20
0
20
40
50
60
80
100
PERCENT EFFECTIVE ROTATION
TOTAL MECHANICAL ROTATION
LEFT TERMINAL
RIGHT TERMINAL

3.4 Total Resistance - The total resistance shall be within the specified tolerance of the nominal resistance, which shall be available from 3 to 25,000 ohms. The mechanical rotation in degrees for the resistance element shall be from 280° to 305°. The total effective electrical rotation shall be at least 280°.

3.5 Mechanical and Visual Inspection - Resistors shall be of the design, construction, and physical dimensions specified. See Figure 1.

3.6 Resistance Taper - The angle at which any percentage of total resistance is effective shall be within ± 5 per cent of the total mechanical rotation of the specified position.

3.7 Minimum Resistance - The minimum resistance shall not exceed 0.3 ohms for resistors of 3 to 50 ohms nominal resistance, 0.5 ohms for resistors 51 to 250 ohms nominal resistance, and 0.2 per cent of nominal resistance for nominal resistance values of more than 250 ohms.

3.8 Insulation Resistance - The initial insulation resistance shall not be less than 100 megohms (See 4.8).

3.9 Dielectric Strength - The resistors shall be capable of withstanding the application of the test potential without damage, arcing, or breakdown.

3.10 Torque

3.10.1 <u>Rotational</u> - The torque required to rotate the contact arm at any position shall be not less than 1.5 ounces-inches nor more than 6 ounce-inches.

3.10.2 <u>Stop</u> - The resistors shall withstand the six pound-inch stop torque without damage.

3.11 <u>Temperature Cycling</u> - The resistors shall be capable of withstanding the temperature cycling without mechanical injury, and the permanent change in total resistance shall not exceed 1 per cent as a result of the cycling (See 4.11).

3.12 <u>Low Temperature Exposure</u> - The torque required to effect rotation of the contact arm during the low temperature exposure test shall not exceed 15 ounce inches. The permanent change in resistance shall not exceed one (1) per cent. Electrical connections shall not be adversely affected and rivets shall not loosen. The movable contact arm shall make uniform electrical connections with the winding.

3.13 <u>Load Life</u> - The change in total resistance of the resistors shall not exceed 1 per cent as a result of the life test specified in 4.14.

3.14 <u>Salt Spray Corrosion</u> - Resistors shall show no marked corrosion; and shall show no disturbance of the ground connection to the mounting panel as a result of the corrosion test specified in 4.15.

3.15 <u>Moisture Resistance</u> - The total resistance shall

not change more than 1 per cent and insulation resistance shall not be less than ten (10) megohms, when tested during the moisture resistance test.

3.16 Rotational Life - Resistors shall not have a permanent change in resistance in excess of 2 per cent nor shall proper contact between resistance elements and rotating arm be broken as the result of 25,000 cycles of rotation.

3.17 Low Temperature Storage - After being subjected to the low temperature storage test specified in paragraph 4.18, the resistors shall meet the requirements of paragraph 3.4.

3.18 Vibration - After subjection to conditions of vibration as outlined in paragraph 4.19, the total resistance shall have changed not more than 2 per cent. There shall be no intermittent contact during the test and no mechanical injury as a result of the vibration test.

3.19 Acceleration - When resistors are tested as specified in 4.20, the change in resistance shall not exceed 2 per cent nor shall there be any evidence of mechanical or electrical damage.

3.20 Shock - When resistors are tested as specified in 4.21 the change in resistance shall not exceed 2 per cent nor shall there be any evidence of mechanical or electrical damage.

TABLE I

Preproduction Approval Test

Test	Test Paragraph	No. of Failures Allowed
Test Group I - All Samples (40)		
Mechanical and Visual Inspection	4.3	
Resistance	4.4	
Insulation Resistance	4.8	
Dielectric Test	4.9	0
Torque	4.10	
Temperature Cycling	4.11	
High Temperature Exposure (225°C)	4.12	
Low Temperature Exposure	4.13	
Test Group II (10 Samples)		
Load Life	4.14	
Salt Spray Corrosion	4.15	
Stop Torque	4.10	3*
Test Group III (10 Samples)		
Moisture Resistance	4.16	
Test Group IV (10 Samples)		
Rotational Life	4.17	
Insulation Resistance	4.8	
Dielectric Test	4.9	
Low Temperature Storage	4.18	
Test Group V (10 Samples)		
Acceleration	4.20	
Shock	4.21	
Vibration (high frequency)	4.19	

* One (1) failure is permissible in each of Test Group II, III, IV, and V with no more than a total of three (3) failures for all test groups combined.

4. INSPECTION AND TEST PROCEDURES

4.1 General - The resistors shall be subjected to the tests specified herein in the order shown to determine compliance with requirements of this exhibit.

4.2 Standard Test Conditions - Unless otherwise specified herein, all measurements and tests shall be performed at 25 ± 5°C and at room ambient pressure, and humidity.

4.3 Mechanical and Visual Inspection - The resistors shall be inspected to verify that their physical dimensions are as specified and workmanship is satisfactory. (See Figure 1).

4.4 Total Resistance - Total resistance of the resistors shall be measured with the contact arm set at the extreme counterclockwise position. The instrument used to perform the total resistance measurement shall be accurate to within ± 0.5 per cent.

4.6 Resistance Taper - Following the measurement of total resistance, resistance measurement shall be made at ten (10) per cent intervals of effective rotation. Resistance values versus per cent effective rotation shall be plotted from the values obtained. The resistance tapers derived shall conform in general shape to nominal curves shown on Figure 1; both for tapers "A" and "C".

4.7 Minimum Resistance - The contact arm shall be rotated to its extreme counterclockwise limit of rotation.

With the arm in this position, the resistance between the counterclockwise terminal and the rotating contact terminals shall be measured. The contact arm shall then be rotated to its extreme clockwise limit of rotation. With the arm in this position, the resistance between the clockwise terminal and the rotating contact terminal shall be measured.

4.8 Insulation Resistance - The insulation resistance from the contact-arm terminal to the mounting bushing, and from the resistance element terminals connected together to the mounting bushing shall be measured. All measurements shall be made using a direct current potential of approximately 100 volts.

4.9 Dielectric Strength

4.9.1 Atmospheric Pressure - A sine-wave test potential of 900 volts rms from an alternating current supply at commercial line frequency of not more than 100 cycles per second shall be applied from all terminals to the bushing for one (1) minute with the contact arm set at the extreme counterclockwise position.

4.9.2 Reduced Pressure - A sine-wave test potential of 550 volts RMS from an alternating current supply at commercial line frequency of not more than 100 cycles per second shall be applied as in paragraph 9a for a period of one (1) minute at a pressure of 2.1 inches of mercury (absolute), with the contact arm set at the extreme counterclockwise position.

4.10 Torque

4.10.1 Rotational - The torque required to rotate the contact arm on the resistance element shall be determined throughout the entire range under standard conditions of temperature and humidity. (Paragraph 4.2)

4.10.2 Stop - Upon completion of the tests in Test Group II, the contact arm shall be rotated to both extremes and the samples shall withstand a torque of not less than six (6) pound-inches applied to the control shaft.

4.11 Temperature Cycling - Resistors shall be subjected to the temperature cycle shown below for a total of 5 cycles performed continuously, 1 cycle following the other. Resistors shall be held at the minimum and maximum temperature for 30 minutes except that they shall be held at the minimum temperature on the fifth cycle for one hour in order to permit the test of paragraph 4.13 to be conducted. The rate of temperature change within the climatic chamber shall be not less than 2°C (3.6°F) per minute. The resistors may be transferred from one chamber to another in which case they shall be kept at room temperature for not less than 10 minutes and not more than 15 minutes between exposure to the extreme temperatures. The total resistance shall be measured (Paragraph 4.4) before cycling and after the fifth cycle. After each measurement of total resistance, the resistance between the contact arm at the low resistance end

of the taper and both element terminals shall also be ascertained.

TEMPERATURE CYCLE

	Degrees "C"	Degrees "F"
Start at	25	77
Reduce to	-65	-67
Return to	25	77
Rise to	85	185
Return to	25	77

4.12 High Temperature Exposure - Resistors shall be placed in an oven at room temperature. The temperature of the oven shall then be elevated gradually to 225°C. The period of the transition from room temperature to the 225°C temperature shall be accomplished in not more than forty-five minutes. The resistors shall then be conditioned at 225°C for a period of two (2) hours. They shall then be allowed to cool gradually to room temperature. The resistors shall be measured for total resistance (see 4.4) before and at the conclusion of this test.

4.13 Low Temperature Exposure - Resistors shall be maintained for one hour at the minimum temperature of -65°C of the last cycle of paragraph 4.11. At the end of one hour, the torque necessary to effect rotation of the contact arm shall be determined by a method satisfactory to the agency concerned. All electrical connections shall be checked. The electrical connection between the rotating contact arm and the winding shall be

checked by connecting an ohmmeter to the arm and one end terminal and slowly rotating the contact arm.

4.14 Load Life

4.14.1 Mounting - During this test resistors shall be mounted on a 4 inch square, 0.050 inch thick, steel panel in still air with their terminals downward. No shielding shall be located closer than 12 inches from the panel.

4.14.2 Test Procedure - Rated nominal wattage shall be applied to resistors at an ambient temperature of 85°C. Power shall be applied intermittently 1-1/2 hours on and 1/2 hour off for a total of 1,000 hours between one of the terminals and the contact arm with the contact arm set so as to introduce the total resistance. Resistance measurements shall be made before the start of this test and periodically at the end of the 1/2 hour off period until 1,000 hours have elapsed.

4.15 Salt-Spray Corrosion - Resistors shall be mounted on an aluminum panel and subjected for 100 hours to the salt-spray corrosion test of MIL-STD-202 (Method 101). At the conclusion of this test the resistors shall be rinsed thoroughly in clean tap water and then permitted to dry for 24 hours at 40°C.

4.16 Moisture Resistance

4.16.1 Initial Measurements - Resistance shall be measured at room conditions (See 4.7).

4.16.2 Exposure - Resistors shall be tested in accordance with Method 106 of MIL-STD-202. No polarising voltage shall be applied.

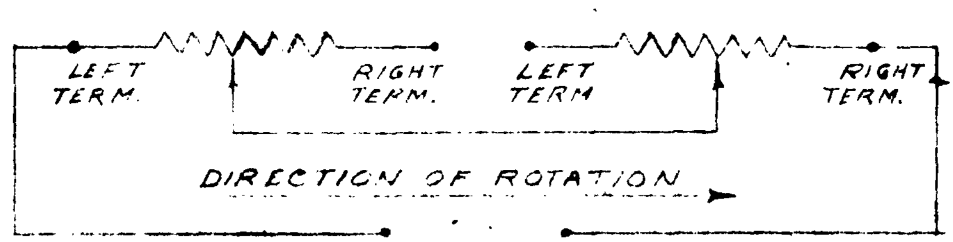
4.16.3 **Final Measurements** - With the samples maintained at the high humidity condition during step seven at the end of the tenth cycle, resistance and insulation resistance shall be measured.

4.16.4 **Measurements Following Moisture Resistance** - The following measurements shall be performed at room conditions after completion of the moisture resistance test, total resistance, torque, insulation resistance, and dielectric strength.

4.17 **Rotational Life**

4.17.1 **Mounting** - Resistors shall be mounted by their bushings and shall be ganged in pairs. The resistors in each pair shall be connected in series so that nominally constant current flows through the resistors irrespective of the contact arm position during the oscillation of the shafts. The shafts shall be so connected mechanically that they shall turn simultaneously in the same direction.

ROTATIONAL LIFE TEST CIRCUIT



4.17.2 Rotation - A direct current potential equivalent to that required to dissipate rated wattage across the entire resistive element of resistors having the same nominal total resistance shall then be applied as shown in the Rotational Life Test Circuit. Resistor shafts shall then be continuously oscillated through not less than 98 per cent of the total mechanical rotation at a rate of approximately 20 oscillations per minute for a total of 25,000 oscillations (an oscillation is defined as the complete traverse from minimum to maximum and return). The total resistance of resistors shall be ascertained at the end of every 5,000 oscillations.

4.18 Low Temperature Storage - Immediately following the tests specified in paragraph 4.9, the resistors shall be placed in a cold chamber maintained at a temperature of -65 ± 2°C for twenty-four (24) hours, after which they shall be removed and maintained at a temperature of 25 ± 5°C for a period of twenty-four (24) hours.

4.19 Vibration - The resistors shall be subjected to vibration frequency cycling between 10 and 2000 cps at an applied double amplitude of 0.060 inch or an applied acceleration of 15g, whichever is the limiting value. The frequency shall be varied logarithmically, and the entire range of frequencies from 10 to 2000 cps shall be traversed in approximately 20 minutes.

The vibration shall be for a period of four hours in each of three mutually perpendicular directions. The vibration cycling may be accomplished in two discrete steps, namely 10 to 500 cps for three hours in each direction, and 500 to 2000 cps for one hour in each direction.

4.20 Acceleration

4.20.1 Mounting - Resistors shall be mounted by their normal means on plates affixed to a mounting fixture which is constructed in such a manner as to insure that the mounting supports remain in a static condition with reference to the acceleration table.

4.20.2 Procedure - After mounting, total resistance shall be measured. Resistors shall be subjected to a constant acceleration of 50 gravity units (g) for a period of a minute in each of two mutually perpendicular planes, one perpendicular and the other parallel to the longitudinal axis of the resistor shaft. Any physical defects occurring during the acceleration may be noted through an appropriate optical system. After this test, total resistance shall be measured.

4.21 Shock

4.21.1 Mounting - Resistors shall be mounted by their normal mounting means, and affixed to a mounting fixture which is constructed in such a manner as to insure that the mounting supports remain in a static condition with reference to the shock table.

4.21.2 <u>Procedure</u> - After mounting, total resistance shall be measured. Resistors shall be subjected to a constant accelerating shock force of 50 g for 11 ± 1 milliseconds in each of two mutually perpendicular planes, one perpendicular and the other parallel to the longitudinal axis of the resistor shaft. A shock test machine in accordance with that described in Specification MIL-S-4456 (USAF) may be used. After this test, total resistance shall be measured.

5. PREPARATION FOR DELIVERY

5.1 Delivery shall be as specified in contract.

6. NOTES

NOTICE: When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government Procurement Operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in anyway supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in anyway be related thereto.

Robert E. Conklin/V. G. Nelson/mfh
WCREC-1 WCREO-1

SPECIFICATION

Resistors, Variable, Wirewound

High Temperature, Sealed

1. SCOPE

1.1 General - These requirements cover a variable wirewound sealed resistor of the high temperature type for use in electronic equipments. These requirements relate to a 5 watt size, 10 to 20,000 ohms with a tolerance of 10 per cent suitable for continuous operation at a temperature from -65°C to +225°C hot spot. All electrical terminations to the variable resistors shall be hermetically sealed. The shaft seal and bushing seal shall be adequate for the resistor to satisfy all requirements of this specification.

2. APPLICABLE PUBLICATION

2.1 The following publications of the issue in effect on date of the invitation for bids shall form a part of this specification to the extent specified herein.

STANDARDS

MILITARY

MIL-STD-202 Test Methods for Electronic and Electric Component Parts.

3. REQUIREMENTS

3.1 Design and Construction - The requirements of this specification are detailed only to the extent considered necessary to obtain the desired objectives. The design, construction, and assembly techniques of the variable wirewound sealed resistors shall be such as to facilitate quantity production reproducibility at reasonable cost. The material and mechanical assembly used in the construction of the resistors, but not specified in detail, shall be of the quality consistent with the proposed and specified performance of the article. Resistors shall be manufactured and processed in a careful and workmanlike manner in accordance with good design and practice.

3.2 Preproduction Samples - Forty (40) of the 10 ohm resistors and forty (40) of the 20,000 ohm resistors shall be subjected to the tests outlined in Table I by the manufacturer and shall have satisfactorily met the requirements of this specification prior to delivery of the resistors called for in the Contract.

3.3 Test Data - Test data covering the preproduction samples submitted to the tests of Table I shall be approved by the Government prior to delivery of the resistors called for in the Contract.

P.R. MALLORY & CO., INC.

ELECTRONIC DIVISION

3/4" HI TEMPERATURE WIRE-WOUND CONTROL

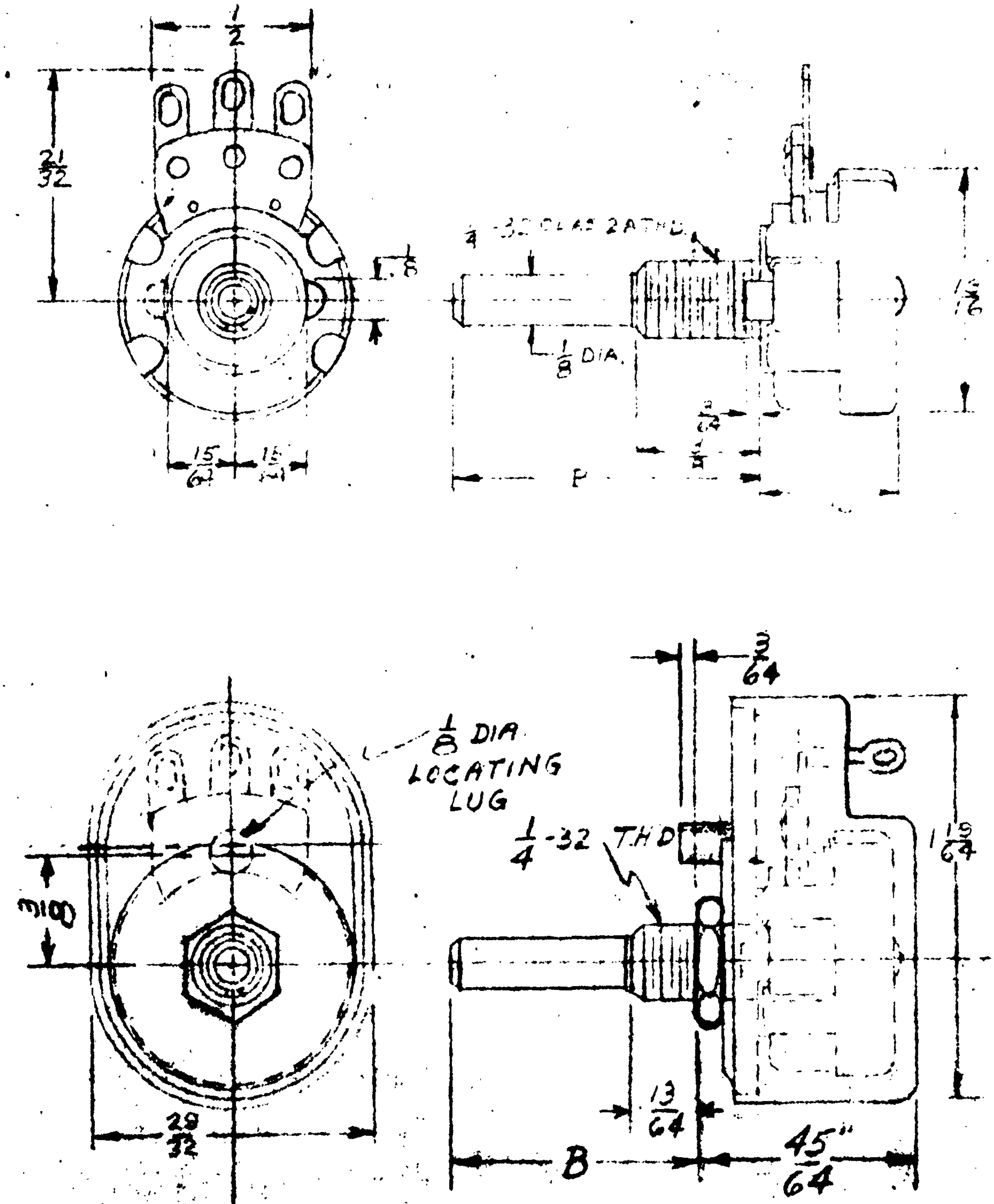


FIGURE 1

TABLE I

Preproduction Approval Test

Test	Test Paragraph	No. of Failures Allowed
Test Group I - All Samples (40)		
Mechanical & Visual Inspection	4.3	
Total Resistance	4.4	
Resistance Taper	4.5	
Minimum Resistance	4.6	
Insulation Resistance	4.7	0
Dielectric Strength	4.8	
Torque (Rotational)	4.9.1	
Temperature Cycling	4.10	
High Temperature Exposure	4.11	
Low Temperature Exposure	4.12	
Test Group II - 10 Samples		
Load Life	4.13	
Salt Spray Corrosion	4.14	
Stop Torque	4.9.2	
Test Group III - 10 Samples		
Moisture Resistance	4.15	
Test Group IV - 10 Samples		
Rotational Life	4.16	3*
Insulation Resistance	4.7	
Dielectric Strength	4.8	
Low Temperature Storage	4.17	
Test Group V - 10 Samples		
Acceleration	4.19	
Shock	4.20	
Vibration	4.18	

*One (1) failure is permissible in each of Test Groups II, III, IV, and V with no more than total of three (3) failures for all test groups combined.

3.4 Total Resistance - The total resistance shall be within a 10 per cent tolerance of the nominal resistance, which shall be available from 10 to 20,000 ohms. The mechanical rotation in degrees for the resistance element shall be from 280° to 305°. (See 4.4)

3.5 Mechanical and Visual Inspection - Resistors shall be of the design, construction, and physical dimensions specified. (See 4.3)

3.6 Resistance Taper - The resistance taper shall conform in general shape to the nominal curve shown in Figure 2. Resistance measurements shall fall within ± 10 per cent of the nominal values shown by the curves at the specified angle of 50 per cent of electrical rotation.

3.7 Minimum Resistance - The minimum resistance shall not exceed 0.3 ohms for resistors of 3 to 50 ohms nominal resistance, 0.5 ohms for resistors of 51 to 250 ohms nominal resistance, and 0.2 per cent of nominal resistance for nominal resistance values of more than 250 ohms. (See 4.6)

3.8 Insulation Resistance - The initial insulation resistance shall not be less than 100 megohms (See 4.7).

3.9 Dielectric Strength - The resistors shall be capable of withstanding the application of the test potential without damage, arcing, or breakdown. (See 4.8)

3.10 Torque - The resistors shall meet the following limits when tested as specified in 4.9.

3.10.1 Rotational - The torque required to rotate the contact arm at any position shall be not less than one inch-ounce nor more than six inch-ounces.

3.10.2 Stop - The resistors shall withstand the six inch-pounds stop torque without damage.

3.11 Temperature Cycling - The resistors shall be capable of withstanding the temperature cycling without mechanical injury, and the permanent change in resistance shall not exceed 5 per cent as a result of the cycling as specified in 4.11.

3.12 High Temperature Exposure - The resistors shall be capable of withstanding the high temperature exposure without mechanical injury, and the permanent change in resistance shall not exceed 5 per cent as a result of this test. (See 4.11)

3.13 Low Temperature Exposure - The torque required to effect rotation of the contact arm during the low temperature exposure test shall not exceed eighteen inch-ounces. The permanent change in resistance shall not exceed 5 per cent. Electrical connections shall not be affected adversely and rivets shall not loosen. The movable contact arm shall make uniform electrical connections with the winding. (See 4.12)

3.14 Load Life - The change in total resistance of the resistors shall not exceed 5 per cent as a result of the life test specified in 4.13.

3.15 Salt Spray Corrosion - Resistors shall show no marked corrosion and shall show no disturbance of the ground connection to the mounting panel as a result of the corrosion test specified in 4.14.

3.16 Moisture Resistance - The total resistance shall not change more than 5 per cent and insulation resistance shall not be less than 10 megohms when tested as specified in 4.15.

3.17 Rotational Life - Resistors shall not have a permanent change in resistance in excess of 5 per cent nor shall proper contact between resistance elements and rotating arm be broken as a result of 10,000 cycles of rotation as specified in 4.16.

3.18 Low Temperature Storage - After being subjected to the low temperature storage test as specified in paragraph 4.17, the resistors shall meet the requirements of paragraph 3.4.

3.19 Vibration - After subjection to conditions of vibration as outlined in paragraph 4.18, the total resistance shall have change not more than 3 per cent. There shall be no intermittent contact during the test, and no mechanical injury as a result of the vibration test.

3.20 Acceleration - When resistors are tested as specified in 4.19, the change in resistance shall not exceed 2 per cent, nor shall there be any evidence of mechanical or electrical damage.

3.21 Shock - When resistors are tested as specified in 4.20, the change in resistance shall not exceed 2 per cent, nor shall there be any evidence of mechanical or electrical damage.

4. INSPECTION AND TEST PROCEDURES

4.1 General - The resistors shall be subjected to the tests specified here in the order shown to determine compliance with the requirements of this specification.

4.2 Standard Test Conditions - Unless otherwise specified herein, all measurements and tests shall be performed at 25° ± 5°C and at room ambient pressure and humidity.

4.3 Mechanical and Visual Inspection - The resistors shall be inspected to verify that their physical dimensions are as specified and that the work is satisfactory. See figure 1 for dimensions.

4.4 Total Resistance - Total resistance of the resistors shall be measured with the contact arm set at the extreme counterclockwise position. The instrument used to perform this measurement shall be accurate to within ± 0.5%.

4.5 Resistance Taper - Following the measurement of total resistance, resistance measurements shall be made at 30, 50, 70, and 100 per cent of electrical rotation.

Per cent of measured resistance versus per cent of electrical rotation shall be determined from the values obtained. The resistance tapers derived shall conform in general shape to the nominal curves shown on figure 2, both for tapers "A" and "C".

4.6 Minimum Resistance - The contact arm shall be rotated to its extreme counterclockwise end of rotation. With the arm in this position, the resistance between the counterclockwise terminal and the rotating contact terminal shall be measured. The contact arm shall then be rotated to its extreme clockwise limit of rotation. With the arm in this position, the resistance between the clockwise terminal and the rotating terminal shall be measured.

4.7 Insulation Resistance - The insulation resistance from all the terminals tied together to the mounting bushing shall be measured. All measurements shall be made using a direct current voltage of approximately 100 volts.

4.8 Dielectric Strength.

4.8.1 Atmospheric Pressure - A sine wave potential of 900 volts RMS, from an alternating current supply at commercial line frequency of not more than 100 cycles per second, shall be applied from all terminals tied together to the mounting bushing for a period of one minute.

4.8.2. <u>Reduced Pressure</u> - A sine wave test potential of 250 volts RMS from an alternating current supply at a commercial line frequency of not more than 100 cycles per second shall be supplied as in paragraph 4.8.1 for a period of one minute at a pressure of 2.1 inches of mercury (absolute).

4.9 <u>Torque</u>

4.9.1 <u>Rotational</u> - The torque required to rotate the contact arm on the resistance element shall be determined throughout the entire range of rotation.

4.9.2 <u>Stop</u> - Upon completion of the tests in Test Group II, the contact arm shall be rotated to both extremes and the samples shall withstand a torque of not less than six inch-pounds applied to the control shaft.

4.10 <u>Temperature Cycling</u> - The resistors shall be subjected to the temperature cycle shown below for a total of 5 cycles performed continuously, 1 cycle following the other. The resistors shall be held at the minimum and maximum temperature for 30 minutes except that they shall be held at the minimum temperature on the fifth cycle for one hour in order to permit the test of paragraph 4.12 to be conducted. The rate of temperature change within the climatic chamber shall be not less than 2°C. (3.6°F) per minute. The resistors may be transferred from one chamber to another, in which case they shall be kept at room temperature for not less than ten minutes and not more

than 15 minutes between exposure to the extreme temperature. The total resistance shall be measured (paragraph 4.3) before cycling and after the fifth cycle. After each measurement of total resistance, the resistance between the contact arm at the low resistance end of the taper and both element terminals shall be measured.

TEMPERATURE CYCLE

	Degrees C	Degrees F
Start at	25	77
Reduce to	-65	-67
Return to	25	77
Rise to	85	185
Return to	25	77

4.11 High Temperature Exposure - The resistors shall be placed in an oven at room temperature. The temperature of the oven shall be elevated then gradually to 225°C. The period of transition from room temperature to the 225°C. temperature shall be accomplished in not more than forty-five minutes. The resistors then shall be conditioned at 225°C for a period of two hours. They then shall be allowed to cool gradually to room temperature. The resistors shall be measured for total resistance (paragraph 4.3) before and at the end of the test.

4.12 Low Temperature Exposure - The resistors shall be maintained for one hour at the minimum temperature of 65°C of the last-cycle of paragraph 4.10.

At the end of one hour, the torque necessary to effect rotation of the contact arm shall be determined by a torque wrench. All electrical connections shall be checked. The electrical connection between the rotating contact arm and the winding shall be checked by connecting an ohmmeter to the arm and one end terminal, and slowly rotating the contacting arm.

4.13 Load Life

4.13.1 Mounting - During this test the resistors shall be mounted on a four inch square .050 inch thick steel panel in still air with their terminals downward. No shielding shall be located closer than twelve inches from each panel.

4.13.2 Test Procedure - Rated nominal wattage shall be applied to the resistors at an ambient temperature of 85°C. Power shall be applied intermittently 1-1/2 hours on and 1/2 hours off for a total of 1,000 hours between the counterclockwise terminal and the contact arm, with the contact arm set on the clockwise terminal. Resistance measurements shall be made before the start of this test and periodically at the end of the 1/2 hour off period until 1,000 hours have elapsed.

4.14 Salt Spray Corrosion - The resistors shall be mounted on an aluminum panel and subjected for 100 hours to the salt spray corrosion test of MIL-STD-202 (Method 101). At the conclusion of this test the resistors shall be rinsed and brushed thoroughly with a short

bristled brush similar to a tooth brush in clean tap water, and then permitted to dry for twenty-four hours at 40°C.

4.15 Moisture Resistance

4.15.1 Initial Measurements - The resistors shall have been measured during Test Group I tests for total resistance, rotational torque, insulation resistance, and dielectric strength.

4.15.2 Exposure - The resistors shall be tested in accordance with Method 106 of MIL-STD-202. No polarizing voltage shall be applied.

4.15.3 Final Measurements - With the resistor maintained at the high humidity condition during step seven at the end of the tenth cycle, resistance and insulation resistance shall be measured.

4.15.4 Measurements Following Moisture Resistance - The following measurements shall be performed at room conditions twenty-four hours after completion of the moisture resistance test: total resistance, rotational torque, insulation resistance and dielectric strength.

4.16 Rotational Life

4.16.1 Mounting - Resistors shall be mounted by their bushings and shall be ganged in pairs. The resistors in each pair shall be connected in series so that nominally constant current flows through the resistors

irrespective of the contact arm position during the oscillation of the shafts. The shafts shall be connected mechanically so that they shall turn simultaneously in the same direction.

4.16.2 Rotation - A direct current potential equivalent to that required to dissipate rated wattage across the entire resistance element of the resistors having the same nominal total resistance then shall be applied as shown in the Rotational Life Test Circuit. The resistor shafts shall then be continuously oscillated through not less than 98% of the total mechanical rotation at a rate approximately 20 oscillations per minute for a total of 10,000 oscillations (an oscillation is defined as the complete traverse from minimum to maximum and return). The total resistance of the resistors shall be measured at the end of 5,000 oscillations and at the end of the test (see paragraph 3.4). Also, at the end of the test, insulation resistance (see paragraph 3.8) and dielectric strength (see paragraph 3.9) shall be measured.

4.17 Low Temperature Storage - Immediately following the tests specified in paragraph 4.16, the resistors shall be placed in a cold chamber maintained at a temperature of -65°C ± 2°C for twenty-four hours,

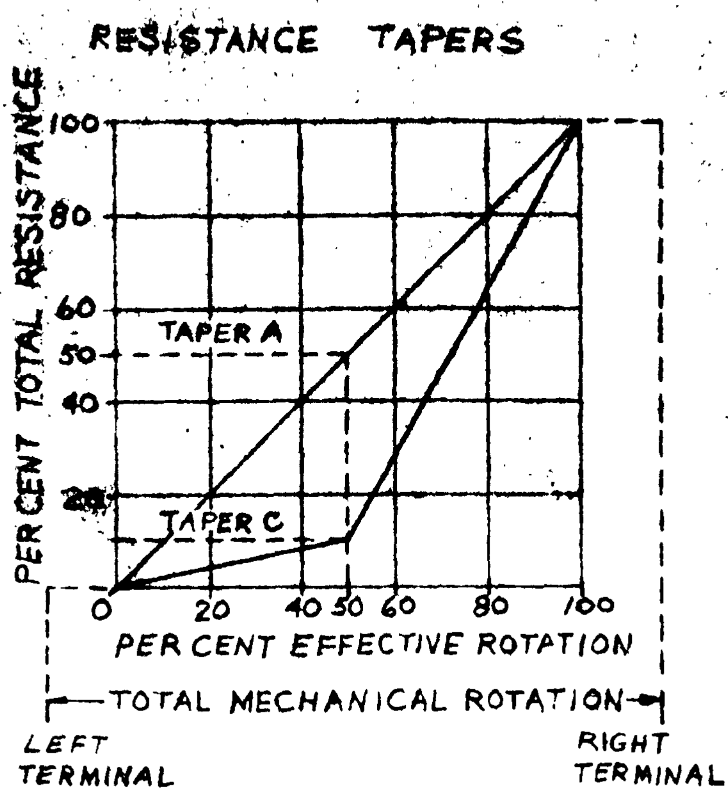


FIGURE 2

ROTATIONAL LIFE TEST CIRCUIT

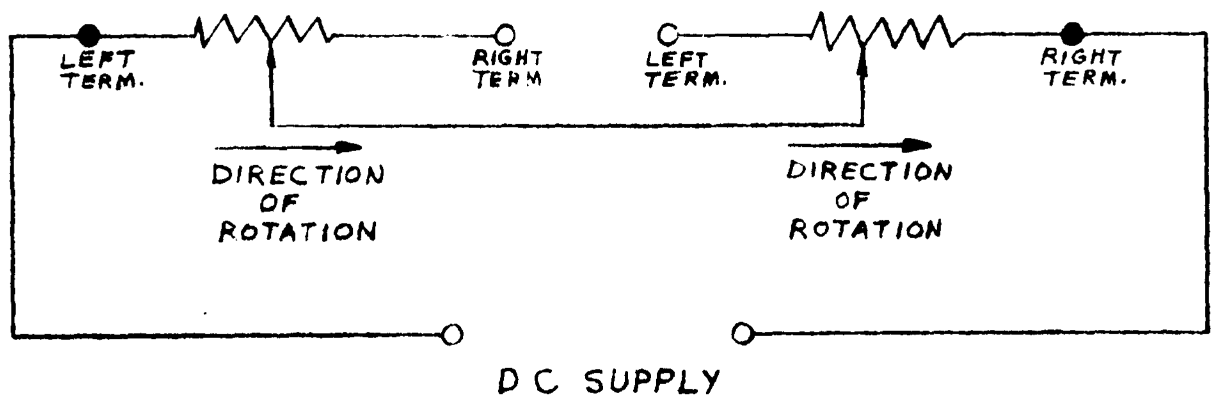


FIGURE 3

after which they shall be removed and maintained at a temperature of 25°C ± 5°C for a period of twenty-four hours. At the end of this time the resistors shall be measured for total resistance, insulation resistance, and dielectric strength.

4.18 Vibration - The resistors shall be subjected to vibration frequency cycling between 10 and 2000 cps at an applied amplitude of .060 inches or an applied acceleration of 15 Gs, whichever is the limiting value. The frequency shall be varied logarithmically, and the entire range of frequencies from 10 to 2000 cps shall be traversed in approximately 20 minutes. The vibration shall be for a period of four hours in each of three mutually perpendicular directions. The vibration cycling may be accomplished in two discrete steps, namely 10 to 500 cps for three hours in each direction, and 500 to 2000 cps for one hour in each direction. After this test, total resistance shall be measured (see paragraph 3.4).

4.19 Acceleration

4.19.1 Mounting - The resistors shall be mounted by their normal mounting means on plates affixed to a mounting fixture which is constructed in such a manner as to insure that the mounting supports remain in a static condition with reference to the acceleration table.

4.19.2 Procedure - After mounting, total resistance shall be measured (see paragraph 3.4). The resistors

shall be subjected to a constant acceleration of 50 Gs for a period of a minute in each of two mutually perpendicular planes, one perpendicular and the other parallel to the longitudinal axis of the resistor shaft. Any physical defects occurring during the acceleration may be noted through an appropriate optical system. After this test, total resistance shall be measured (see paragraph 3.4).

4.20 Shock

4.20.1 Mounting - The resistors shall be mounted by their normal mounting means, and affixed to a mounting fixture which is constructed in such a manner as to insure that the mounting supports remain in a static condition with reference to the shock table.

4.20.2 Procedure - After mounting, total resistance shall be measured (see paragraph 3.4). The resistors shall be subjected to a constant accelerating shock force of 50 Gs for 11 ± 1 millisecond in each of two mutually perpendicular planes, one perpendicular and the other parallel, to the longitudinal axis of the resistor shaft. A shock test machine in accordance with that described in Specification MIL-S-4456 (USAF) may be used. After this test, total resistance shall be measured (see paragraph 3.4)

5. PREPARATION FOR DELIVERY

5.1 Delivery shall be as specified in the Contract.

6. NOTES

NOTICE

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government Procurement Operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in anyway supplied the said drawings, specifications or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation or conveying any rights or permission to manufacture, use or sell any patented invention that may in anyway be related thereto.

STANDARD PRODUCTION EQUIPMENT AND

MODIFICATIONS TO STANDARD PRODUCTION EQUIPMENT

There was no standard production equipment permanently assigned to this contract.

There was a number of special temporary tools, dies, jigs, and fixtures used to produce these variable resistors, but they were sold to the Contractor (Mallory Controls Company) on Plant Clearance Case Nr. IND-I-1679 dated January 19, 1962.

In most cases tool, jigs, and dies were mounted in the appropriate machine temporarily to make the number of parts needed. These machines are the property of the Mallory Controls Company.

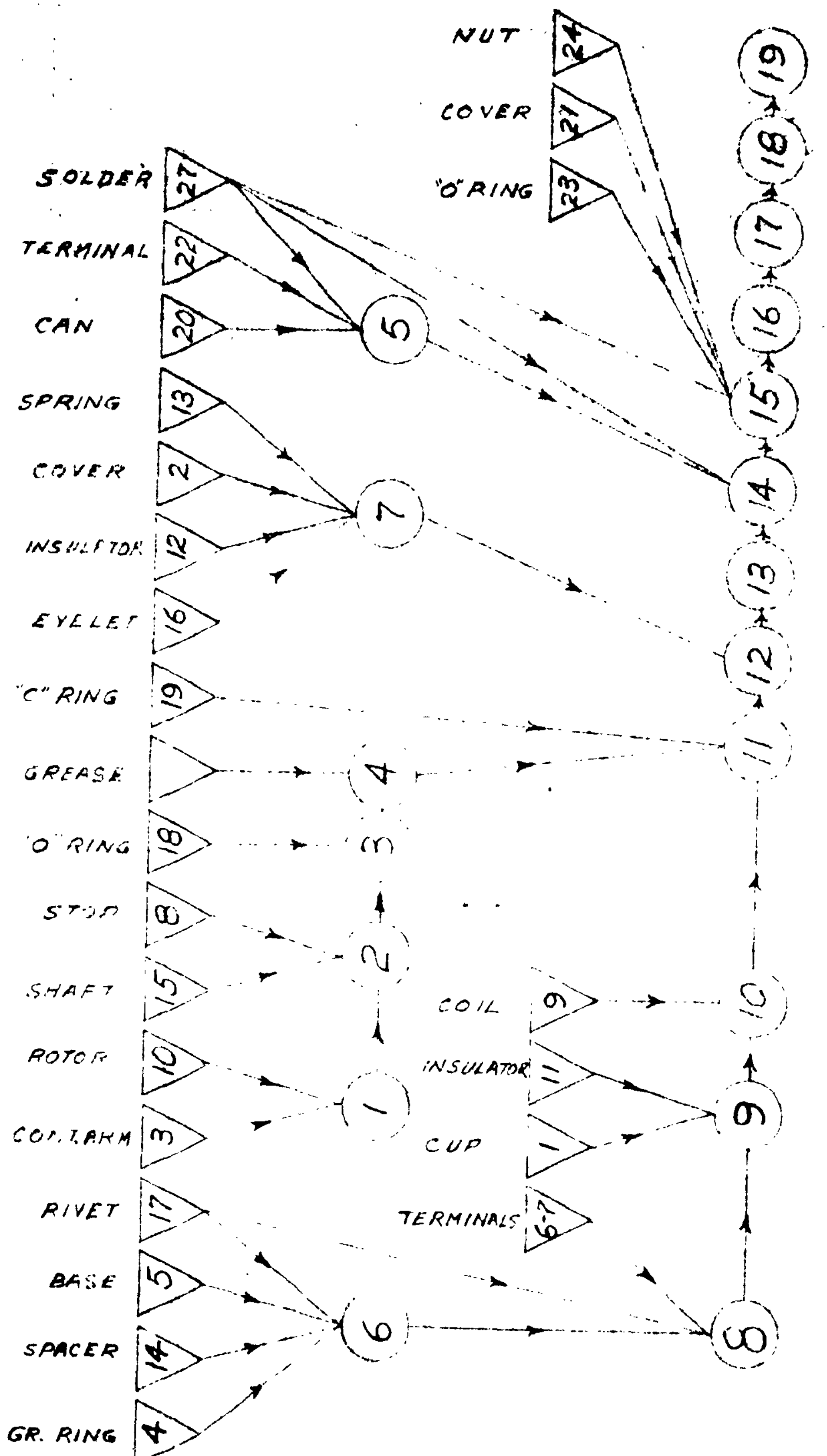
SHAFT SIZE:	DRWG # 70-02729
ROUTING SHEET	TYPE: "SS" Control
WITH/WITHOUT SWITCH:	CUSTOMER: Government
SUB # 5	DATE: July 3, 1962

OPERATION DESCRIPTION	OPER. #	HRS/C	LABOR GRADE	PCS/HR
Asb. & Clinch Contact Arm To Rotor	1	.250	I	400
Asb. & Stake Rotor & Stop To Shaft	2	.400	I	250
Asb. 3 "O" Rings To Shaft	3	.283	I	355
Grease Shaft With DC11 Grease	4	.125	I	800
Solder 3 Herm. Sealed Terminals to CAN	5	.625	I	160
Asb. & Rivet Spacer & Ground Ring To Base	6	.305	I	328
Asb. & Rivet Insulator & Spring To Cover	7	.650	I	154
Asb. & Rivet 2 Terminals To Base	8	.297	I	337
Asb. Base & Insulator To Cup	9	.257	I	389
Asb. Coil To Cup	10	.259	I	386
Asb. Shaft to Cup - Asb. & Clinch "C" Ring To Shaft - Grease Coil In Cup	11	.403	I	248
Asb. & Clinch Cover To Cup	12	.143	I	700
Inspect Control	13	.500	IV	200
Asb. Control to H.S. Can & Solder Control Terminals To H. S. Terminal	14	1.333	I	75
Asb. "O" Ring, H.S. Cover & Nut To Control & Seal With Solder	15	.318	I	315
Tighten Nut To Bushing	16	.125	I	800
Inspect Hermetic Seal	17	1.110	IV	90
Final Inspect	18	.350	IV	287
Pack	19	.125	III	800

ISSUED BY: JEA

Best Available Copy

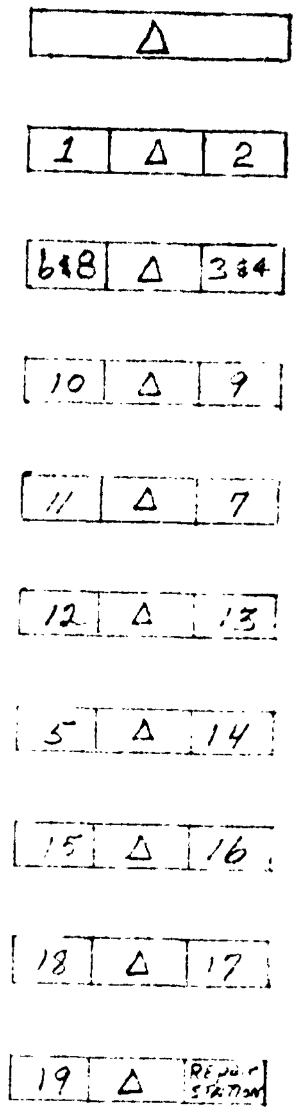
FLOW CHART FOR 3/4-INCH WIRE WOUND CONTROL MALLORY CONTROLS CO. TYPE-"SS"



▽-DELAYED STORAGE & ITEM NUMBERS FROM MALLORY PR. 70-02729
○OPERATION & OPERATON Nº PER MALLORY PROCESS ROUTING SHEET

LAYOUT FOR 3/4" WIRE WOUND CONTROL

MALLORY TYPE "SS"



SCALE - 1/8" PER FOOT

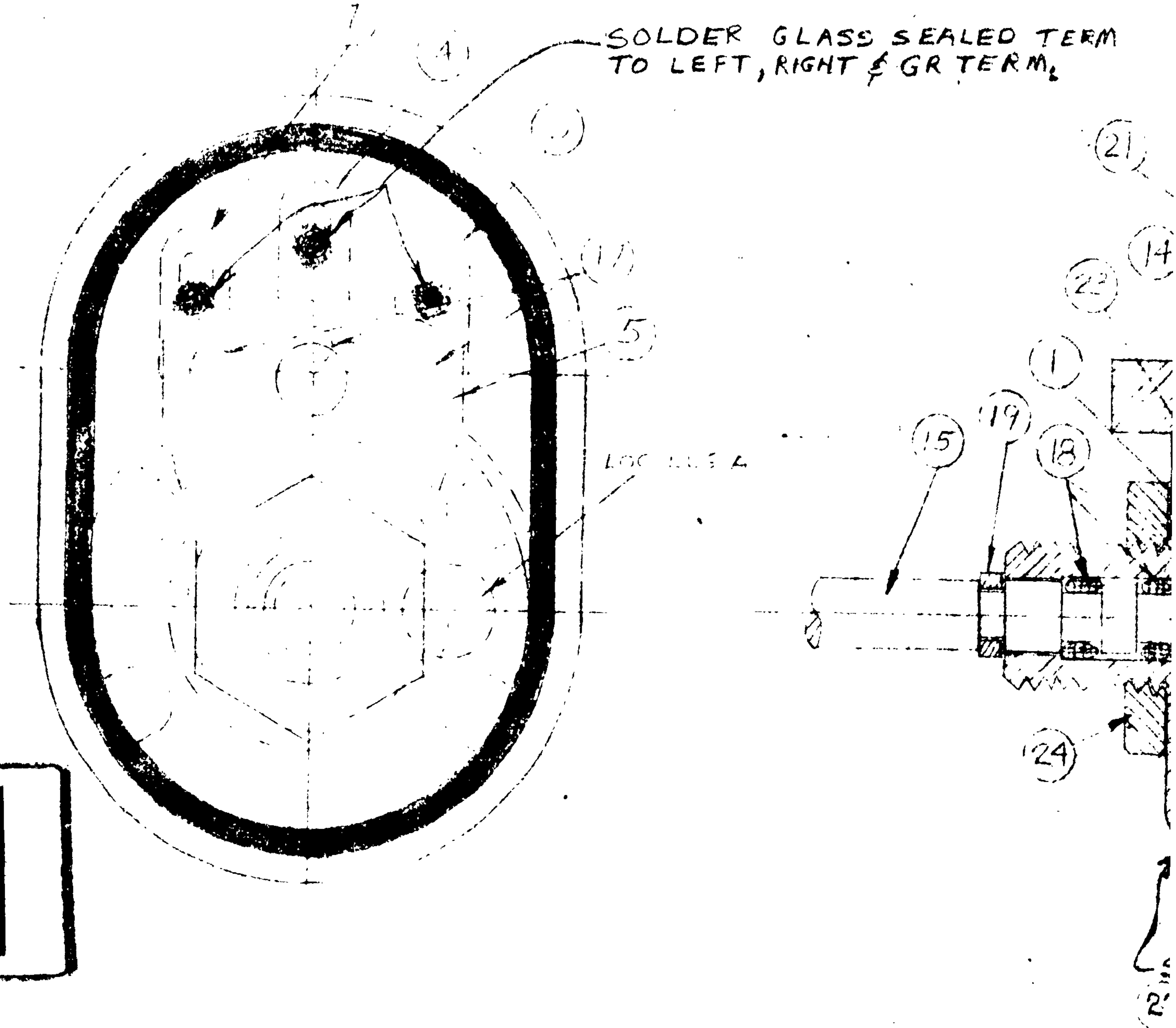
NUMBERS INDICATE OPERATIONS PER ROUTING SHEET

Δ - MATERIAL & IN PROCESS STORAGE

DISTRIBUTION LIST

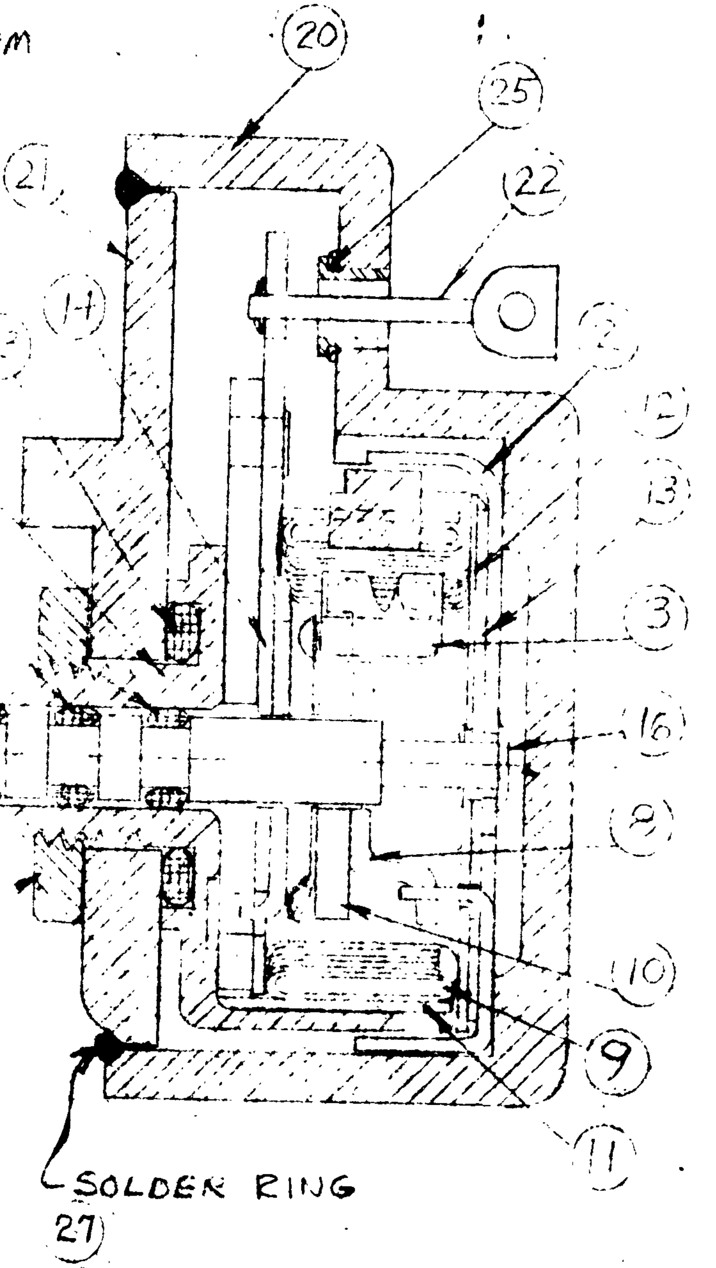
(Limited Distribution)

Addressee	Quantity
Armed Service Technical Information Agency (ASTIA) Arlington Hall Station Arlington 12, Virginia	10
ASD (ASNPVE) Wright-Patterson AFB, Ohio	2
ASD (ASRCTE) Wright-Patterson AFB, Ohio	7 and One(1) reproducible
ASD (ASRKRA) Wright-Patterson AFB, Ohio	1



1

LUBRICATE ... TO & INCLUDING
... 11 ... AFTER
"O" RING ... SHAFT
LUBRICATE GROUNDRING, COIL, AND REAR BEARING BEFORE
COVER IS ADDED ... 11



P. R. MALLORY & CO., INC. INDIANAPOLIS INDIANA

DATE 6-[illegible]

DRAWN BY [illegible]

B-70-02729

"SS" [illegible]

PIECES PER UNIT	REFERENCE	PART NO.	ITEM	DESCRIPTION
1	70-[illegible]	2	1	[illegible]
1	70-[illegible]	1	2	C[illegible]
1	70-[illegible]		3	[illegible]
1	70-[illegible]	1	4	[illegible]
1	[illegible]		5	B[illegible]
1	70-[illegible]	1	6	[illegible]
	[illegible]		7	L[illegible]
1	[illegible]	1	8	[illegible]
	SEE [illegible]		9	[illegible]
1	70-[illegible]	1	10	[illegible]
	[illegible]	1	11	[illegible]
1	70-[illegible]		12	[illegible]
1	70-[illegible]	1	13	[illegible]
	70-[illegible]	1	14	[illegible]
	SEE [illegible]		15	[illegible]
	[illegible]		16	EY[illegible]
	[illegible]	12	17	[illegible]
	70-[illegible]		18	[illegible]
1	70-[illegible]		19	[illegible]
	70-[illegible]		20	[illegible]
1	70-[illegible]	1	21	[illegible]
3	70-[illegible]		22	TE[illegible]
1	70-[illegible]	2	23	[illegible]
	70-[illegible]	1	24	M[illegible] NUT
3	70-02793	1	25	S[illegible]
			26	
1	70-03008	1	27	SOLDER RING
			28	
			29	
			30	
			31	
			32	
			33	
			34	
			35	
			36	
			37	
			38	
			39	
			40	

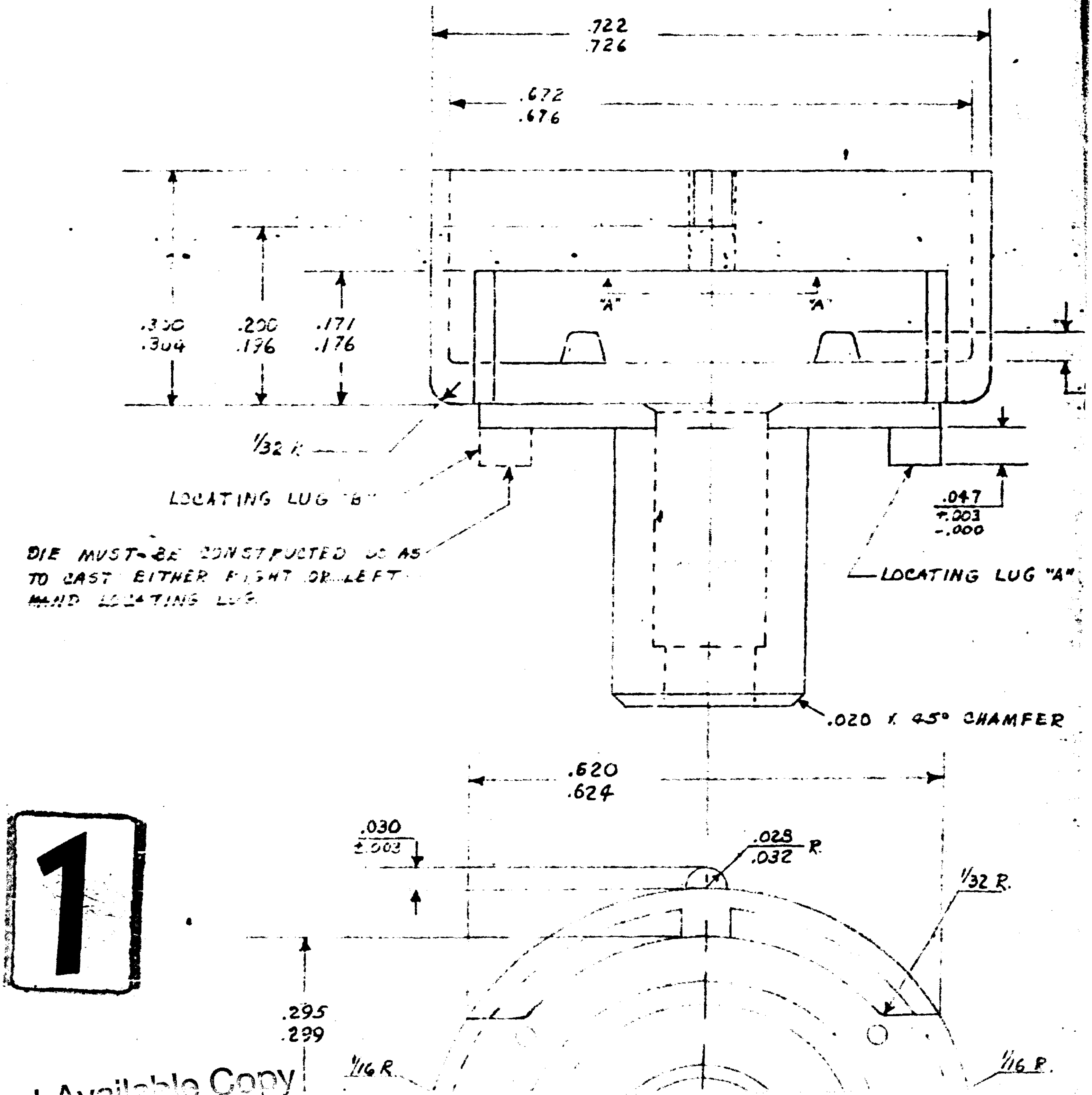
SUB	CHANGES	MEMO
0	ECR 70-[illegible]	
1	CHANGED TIE FROM 5 to 55 WCN 6-26-58	ECA 70-4637
2	ADDED ITEM 27 LGEO.	BSE 70-2252
3	REVISED [illegible] NOTE DS 12-22-58	ECN 70-5554
4	DC. 11 WAS DC. 14 [illegible] E 3-59	ECN 70-6504
5	[illegible] (HEAVY) ADDED DC-11 [illegible]	ECN 70-6626
6	[illegible] ITEM 26 [illegible] TAPE [illegible]	

B-70-02729

2

REVISIONS

19	REDRAWN NO CHANGES 12-6-60. E.F. NO MEMO
20	ADDED NOTE 3. .015 R. & 1/64 R. CHANGED TO .031 R. 12-21-60. L.R.B. MEMO ELN 70-0715
21	ADD PT. 6 FOR FUTURE USE. D.S. 4-19-62
22	CHANGED FLAT ON PT. 4 FROM .63 to .24 C. WON 6-29-62



1

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FORMERLY

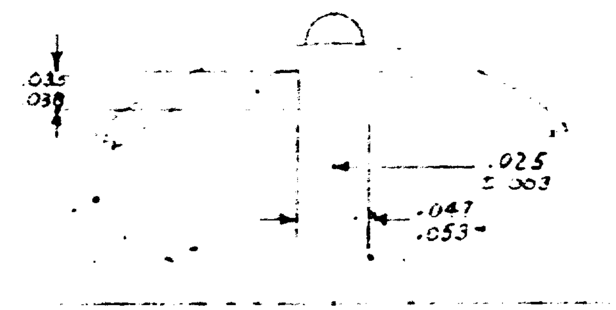
MALLORY

DRAWN BY: C. ...

DATE: 9-21-56

SCALE: 6X | APPR. | DIST.

PART	ITEM	QUAN.	
1			ZAMAK #3
2			" "
3			" "
4			" "
5			" "
6			" "



SECTION "A" "A"

.035
.040

▲ .0001 TO .0003 NICKEL (FOR

✱ PURCHASE COMPLETE.

★ GOLD FLASH FOR FINISH.

NOTE 1. VENDOR SHALL FUR

CAVITY EACH TIME

NOTE 2: APPROVED VENDOR

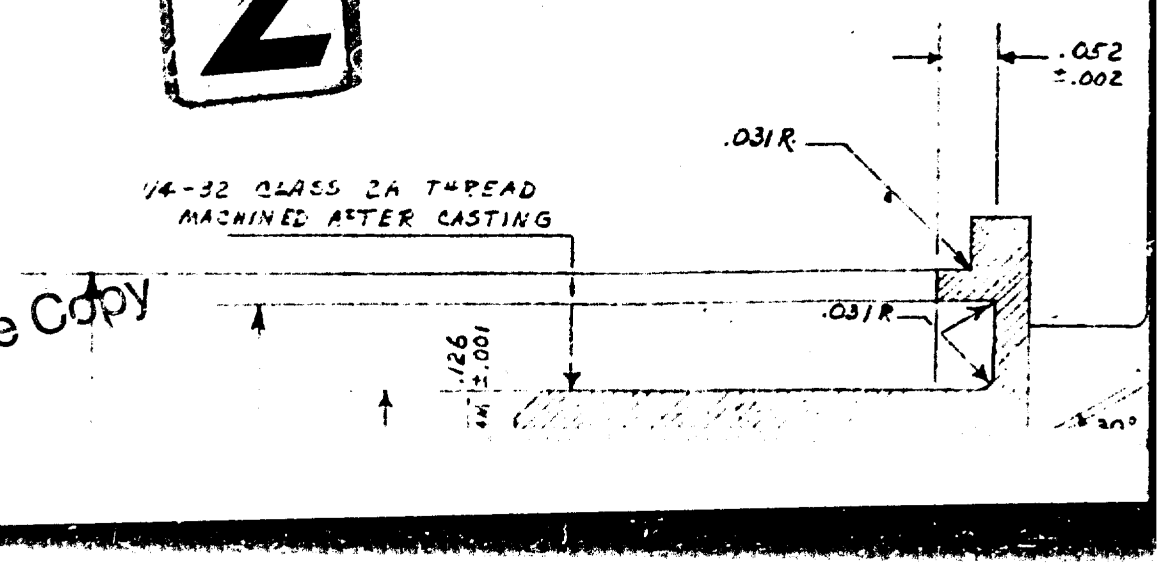
NOTE 3: THE .126 ±.001 DIM

THE .243-.249 D

...G "A"

MFER

2



1/16 R.

Best Available Copy

MALLORY

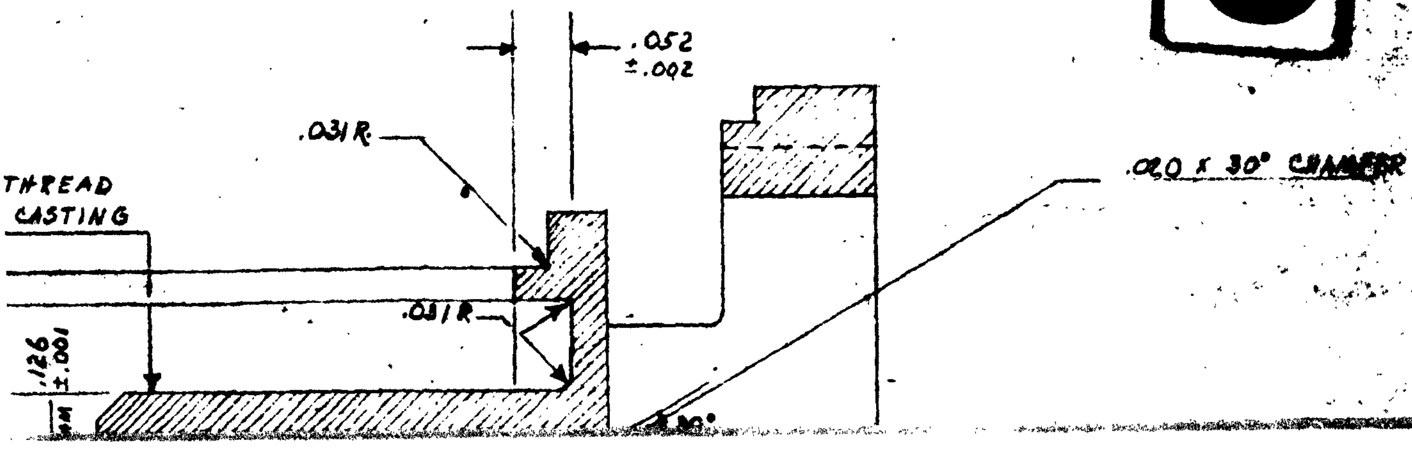
CUP
3/4 INCH CONTROL

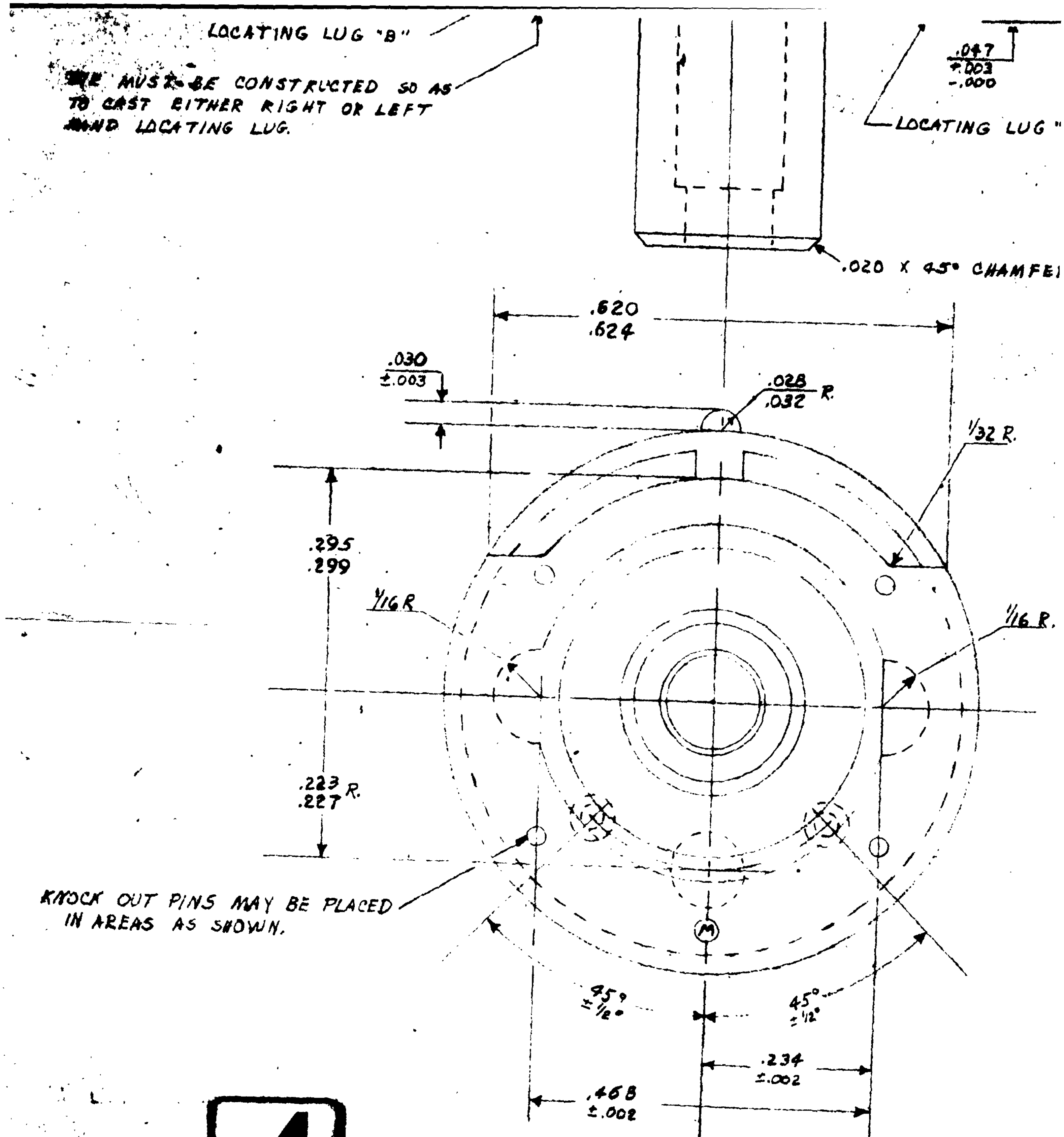
SCALE 6X

PART	ITEM	QUAN.	MATERIAL - DESCRIPTION	CODE	FINISH	[illegible]
1			ZAMAK #3 LOCATING LUG "A"	*		
2			" " " " "A"		▲	
3			" " " " "A"		[illegible]	
4			" " " " "A"		24C	
5			" " " " "B"		▲	
6			" " " " B	*		

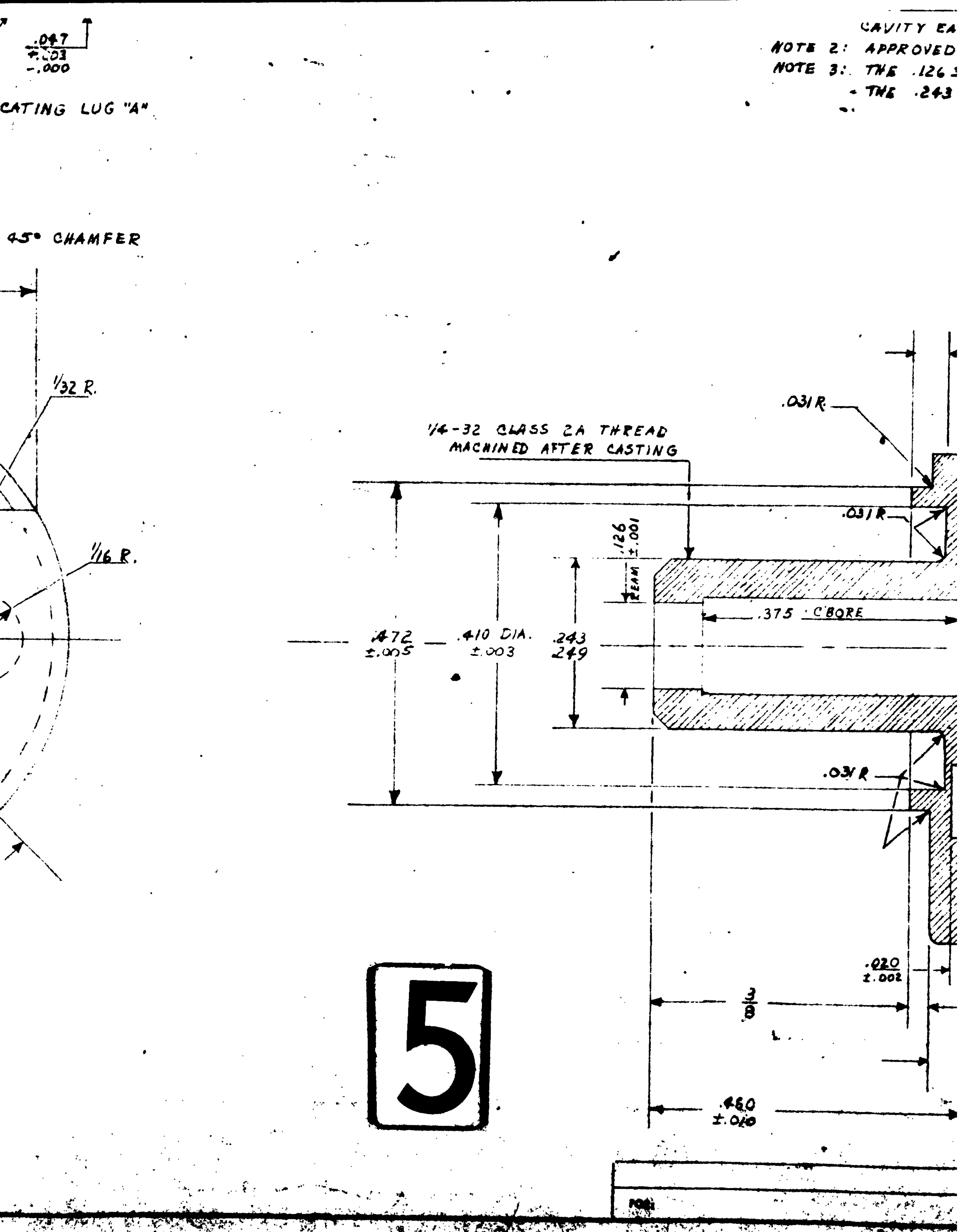
▲ .0001 TO .0003 NICKEL (FOR BRIGHTNESS). GOLD FLASH .000005-.000010.
* PURCHASE COMPLETE.
★ GOLD FLASH FOR FINISH.
NOTE 1: VENDOR SHALL FURNISH A MINIMUM OF 3 CUPS FROM EACH CAVITY EACH TIME AN ORDER IS RUN.
NOTE 2: APPROVED VENDOR FOR GOLD PLATING: PRECISION ELECTRO-PLATING [illegible]
NOTE 3: THE .126 ±.001 DIM. MUST BE CONCENTRIC WITHIN .008 T.I.R. WITH THE .243-.249 DIM.

3




LOCATING LUG "B"
MUST BE CONSTRUCTED SO AS TO CAST EITHER RIGHT OR LEFT HAND LOCATING LUG.
.047 +.003 -.000
LOCATING LUG "
.020 X 45° CHAMFE
.620 .624
.030 ±.003
.028 .032 R.
1/32 R.
.295 .299
1/16 R
1/16 R.
.223 .227 R.
KNOCK OUT PINS MAY BE PLACED IN AREAS AS SHOWN.
M
45° ±1/2°
45° ±1/2°
.234 ±.002
.468 ±.002

4

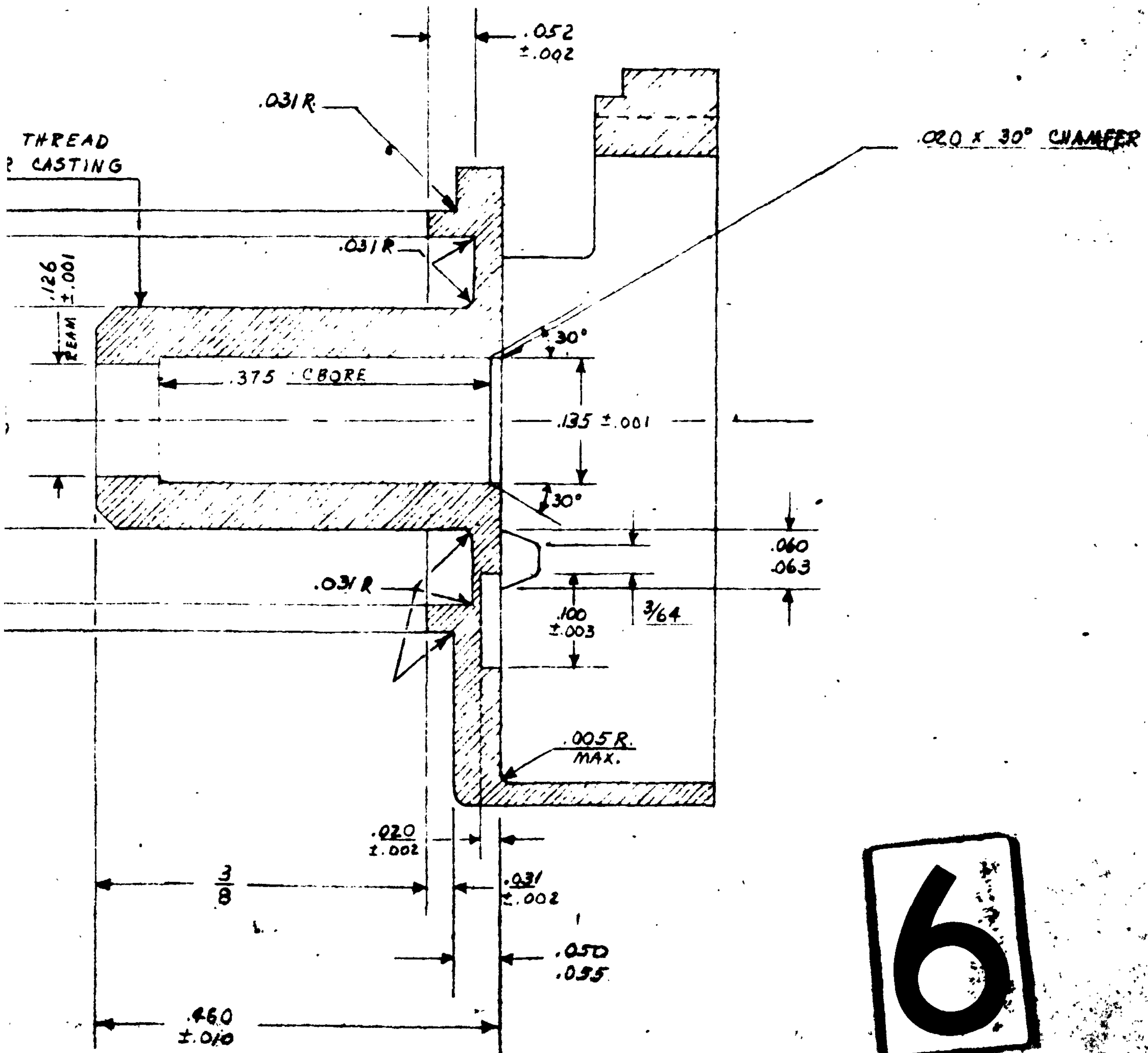


.047
+.003
-.000
CATING LUG "A"
45° CHAMFER
1/32 R.
1/16 R.
CAVITY EA
NOTE 2: APPROVED
NOTE 3: THE .126
THE .243
.031 R.
1/4-32 CLASS 2A THREAD
MACHINED AFTER CASTING
.126
±.001
REAM
.031 R.
.375 C'BORE
.472
±.005
.410 DIA.
±.003
.243
.249
.031 R
.020
±.002
3/8
.460
±.010
5

CAVITY EACH TIME AN ORDER IS RUN.

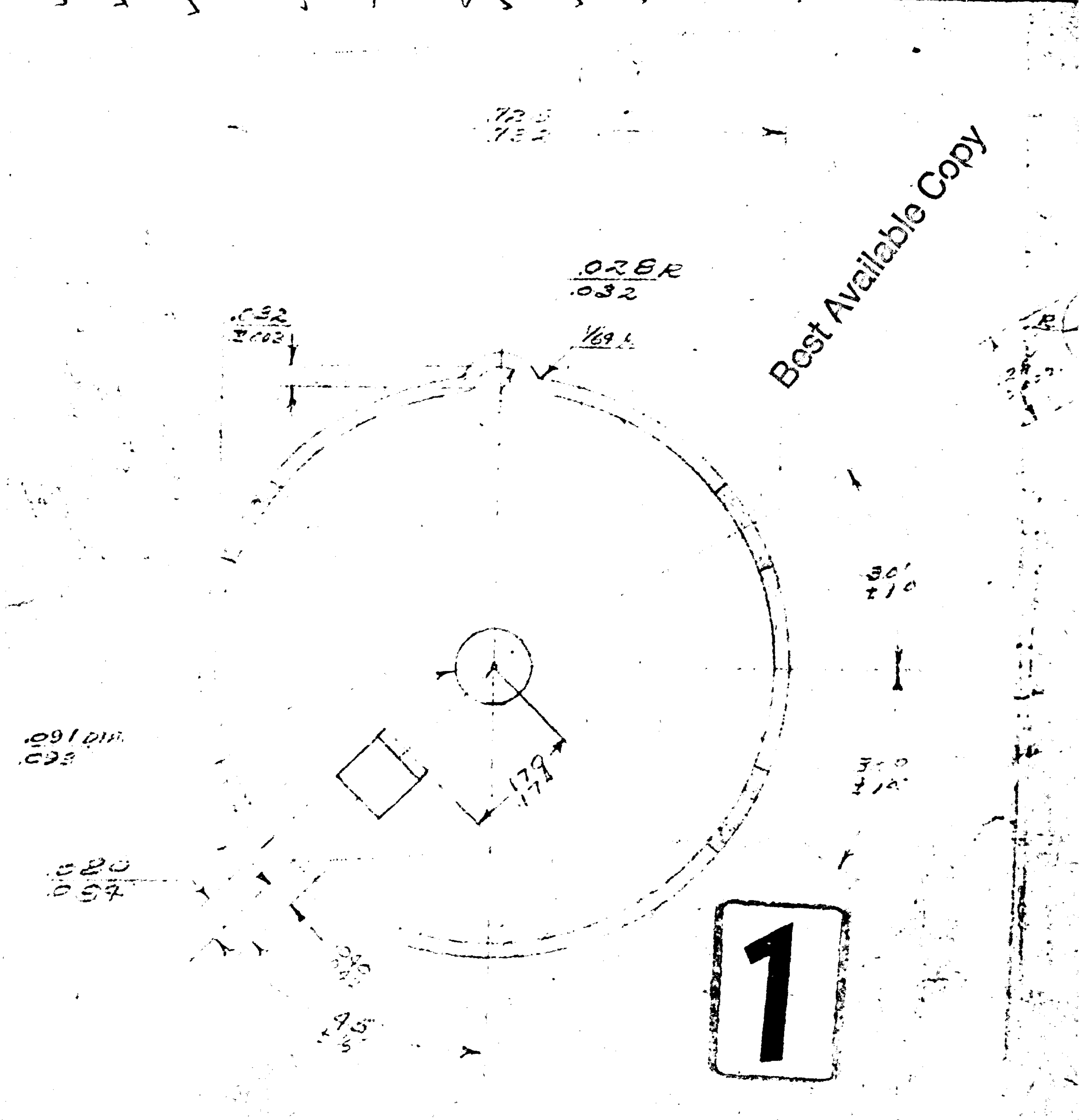
NOTE 2: APPROVED VENDOR FOR GOLD PLATING: PRECISION ELECTR

NOTE 3: THE .126 ±.001 DIM. MUST BE CONCENTRIC WITHIN .00 T.I.R. WITH THE .243 -.249 DIM.



6

REVISIONS
0 ECN 70-4330 WON 5-6-58
1 REVISE STOP DETAILS - L.C. ECN-70-4554 6-9-58
2 ADDED CODE & WEIGHT. L.C. 8-11-58 ECN-70-4815
3 ADD PT 3 FOR COMM. WON 11-28-58 ESR 70-5547
4 WEIGHT WAS 7#, L.C. 12-30-58 ECN 70-5593
5 CHANGED STOP LOCATION ECN 70-5668
6 DIM A WAS .557 ±.005 ECN 70-6561 R.A.C. 6-10-59
7 ADDED NOTE JAF 4-25-60 ECN 70-7832
8 CHANGED MAT'L ON PT. 1 FROM BRASS TO STEEL WON 6-12-62



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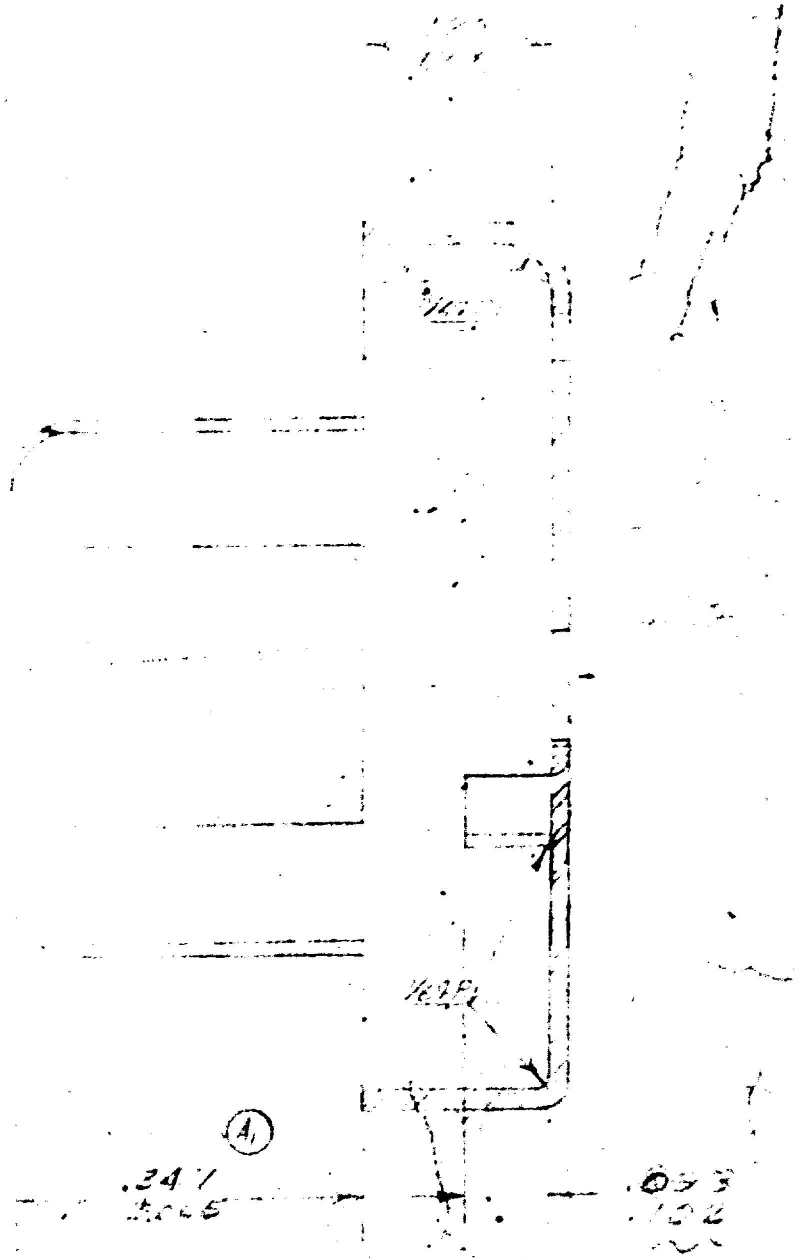
MULTI - 1.697

MALLORY

SCALE: 6X	TITLE: COVER	70-02697
DRAWN: DATE: / APPR.	DIST. 91#	DIVISION / DO NOT SCALE - ALL DIMENSIONS IN INCHES

PART	ITEM	QUAN.	MATERIAL - DESCRIPTION	CODE		
1			.015 C.R.S. SOFT (*4 TEMPER)	63420	24	[illegible]
2			.018 BRASS (DEEP DRAWING)	62746	[illegible]	[illegible]
3			.018 C.R.S. SOFT (*4 TEMPER)	63420	22	[illegible]

* .0001 TO .0003 NICKEL (FOR BRIGHTNESS)
GOLD FLASH .00005 - .00010
APPROVED VENDOR FOR GOLD PLATING:
PRECISION ELECTRO-PLATING CO.



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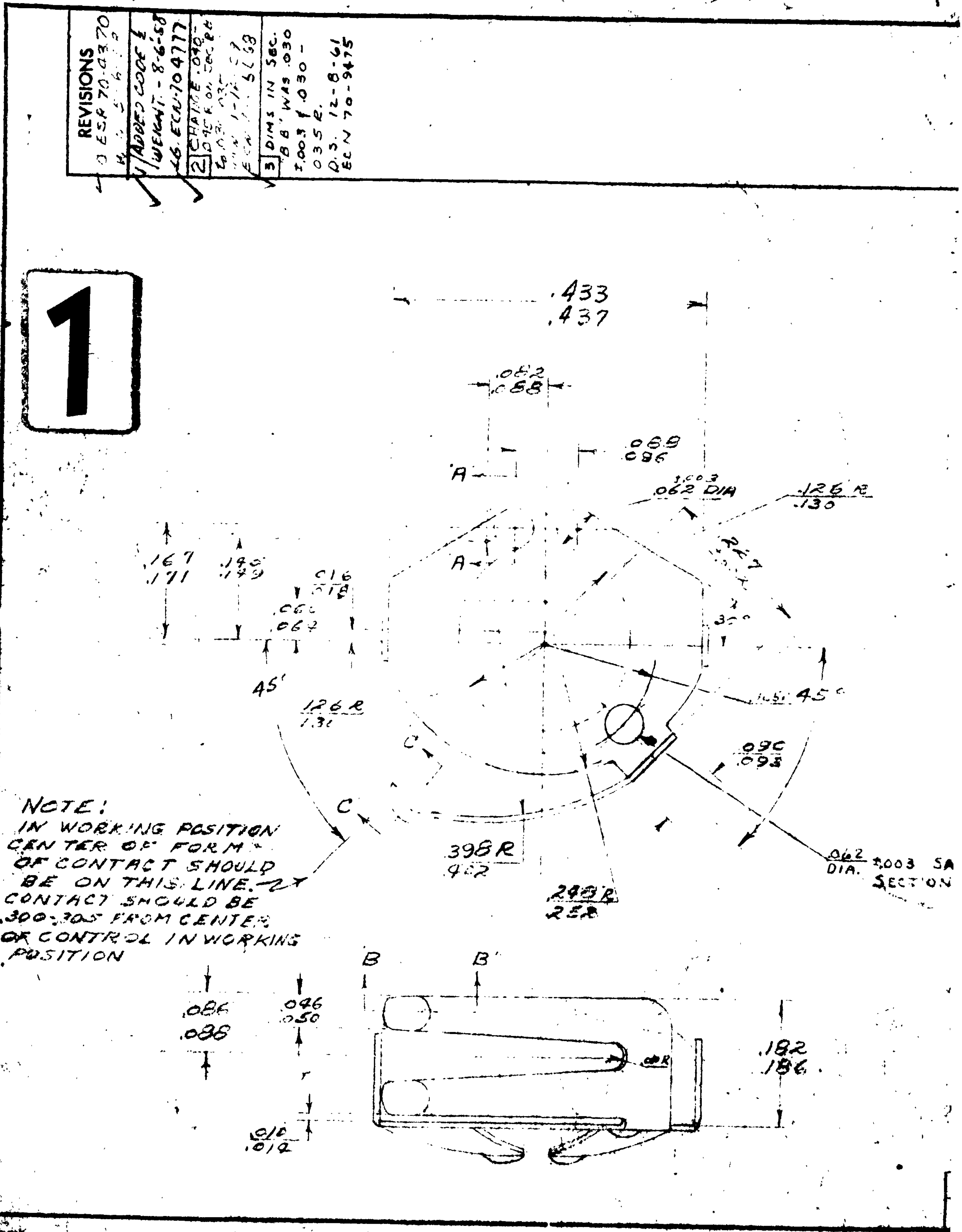
2

FOR:

70-02697

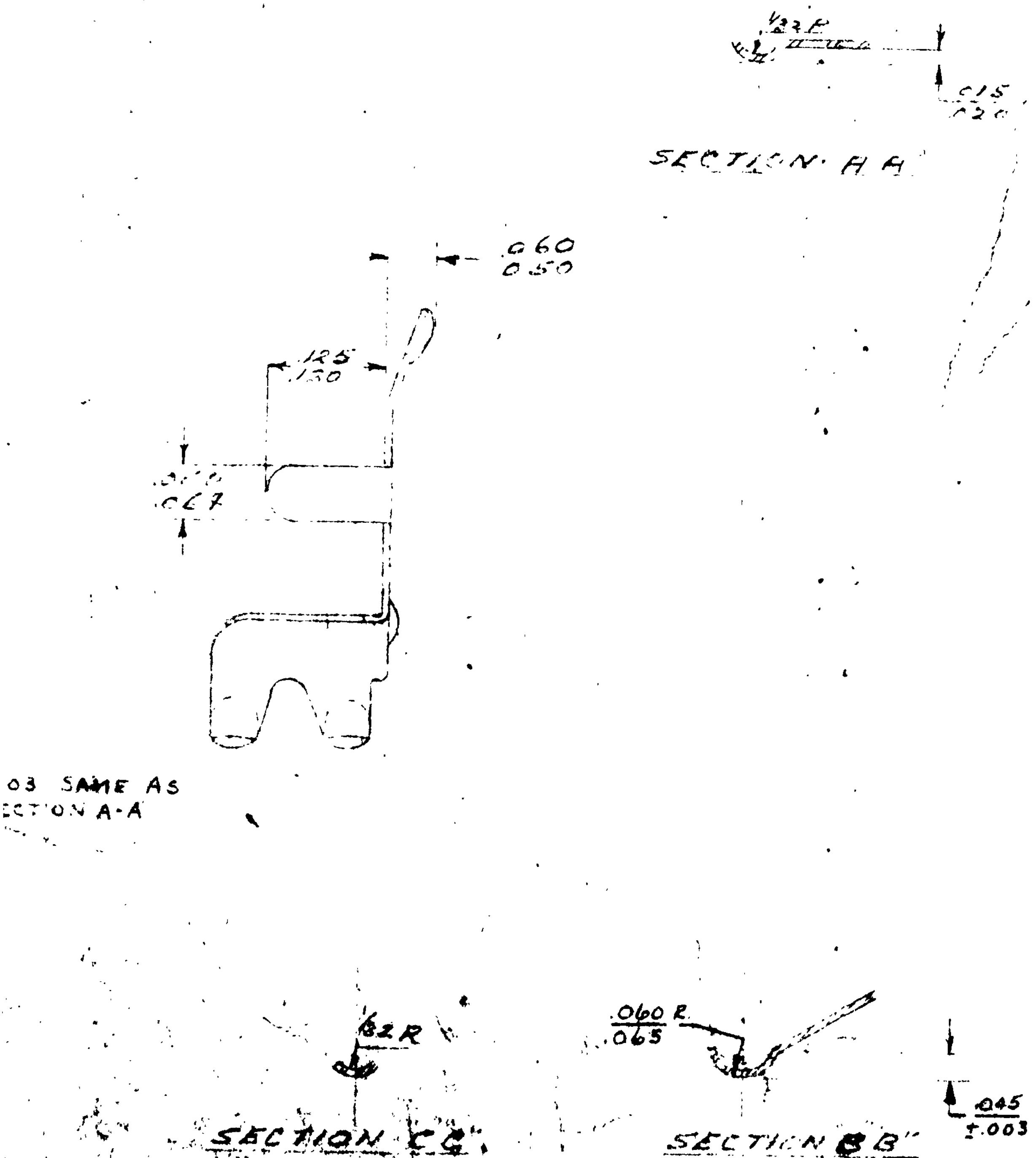

REVISIONS
1
.433
.437
A
A
C
C
45°
B
B
NOTE:
IN WORKING POSITION CENTER OF FORM OF CONTACT SHOULD BE ON THIS LINE.
CONTACT SHOULD BE .300-.305 FROM CENTER OF CONTROL IN WORKING POSITION
.398 R
.182
.186

FB6516

MALLORY
Main Offices Indianapolis, Ind., U.S.A.

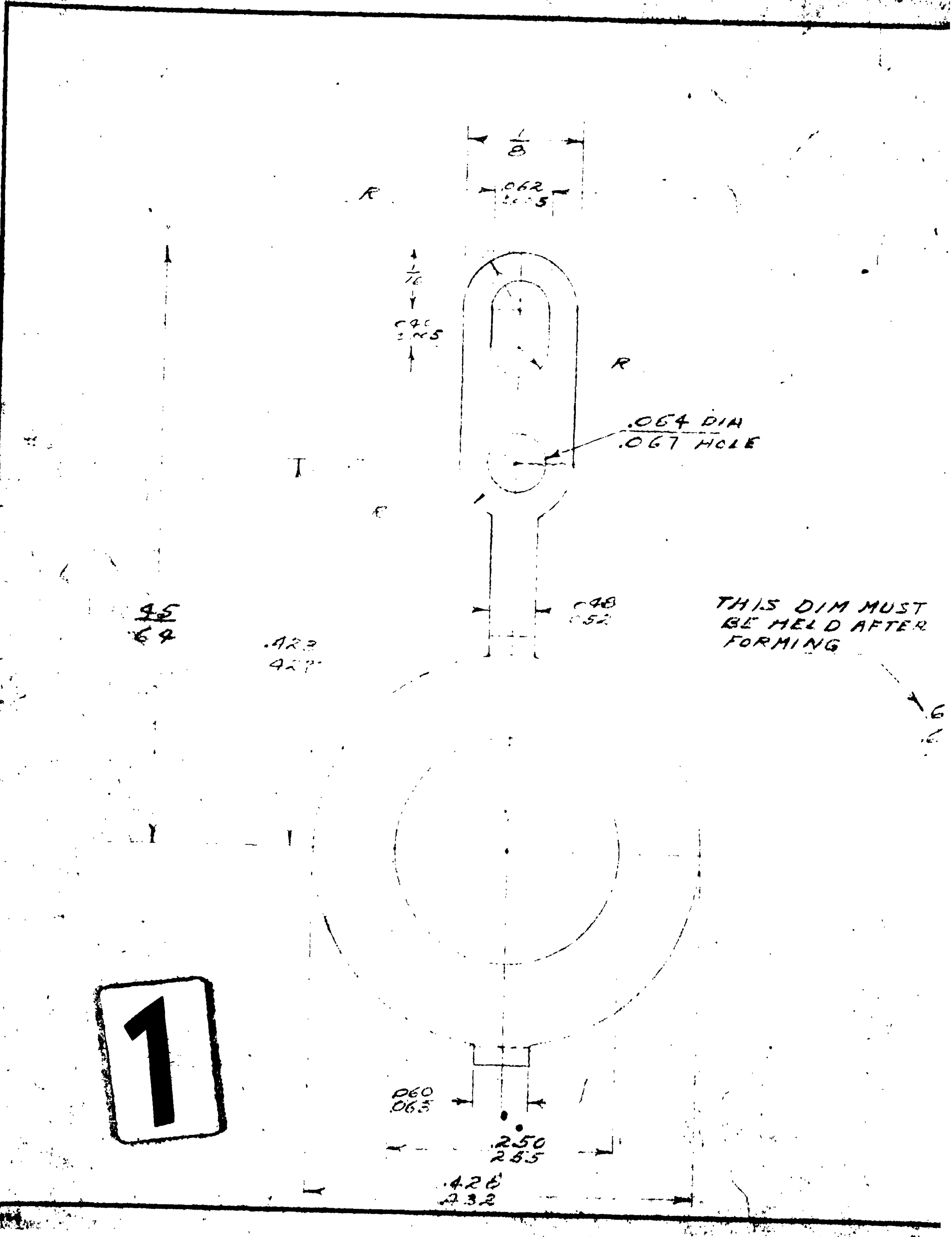
DRAWN BY: C BUSH	DATE: 1-7-57	TITLE: CONTACT ARM 3/4 INCH. CONTROL	70-026[illegible]
SCALE: 4X	APPR.	DIST.	UNLESS OTHERWISE SPECIFIED ... MALS ± .005—FRACTIONS ± ... DO NOT SCALE—ALL DIMENSIONS ... INCHES DIMENSIONS ...

PART	ITEM	QUAN.	MATERIAL - DESCRIPTION	CODE	FINISH	WT.
1			.066 THICK NICKEL SILVER (12%) HARD TEMPER (P.S. 6-026)	62726	—	1.[illegible]



2

FOR:



1/8
1/16
R
R
.064 DIA
.067 HOLE
45/64
THIS DIM MUST
BE HELD AFTER
FORMING
.060
.065
.250
.255
1

VB 6517

P. R. MALLORY & CO., Inc.
INDIANAPOLIS, INDIANA, U. S. A.

TITLE GROUND RING 3/4 INCH

DO NOT SCALE. ALL DIMENSIONS ARE IN INCHES. TOLERANCES UNLESS OTHERWISE SPECIFIED: DECIMALS ±.005, FRACTIONS ±.005, ANGLES ±1½°. DIAMETERS CONCENTRIC WITHIN .005 TOTAL INDICATOR READING. ALL DIMENSIONS SHOWN ARE BEFORE PLATING. GENERAL PURCHASE SPECIFICATION P.S. 10710 APPLIES.

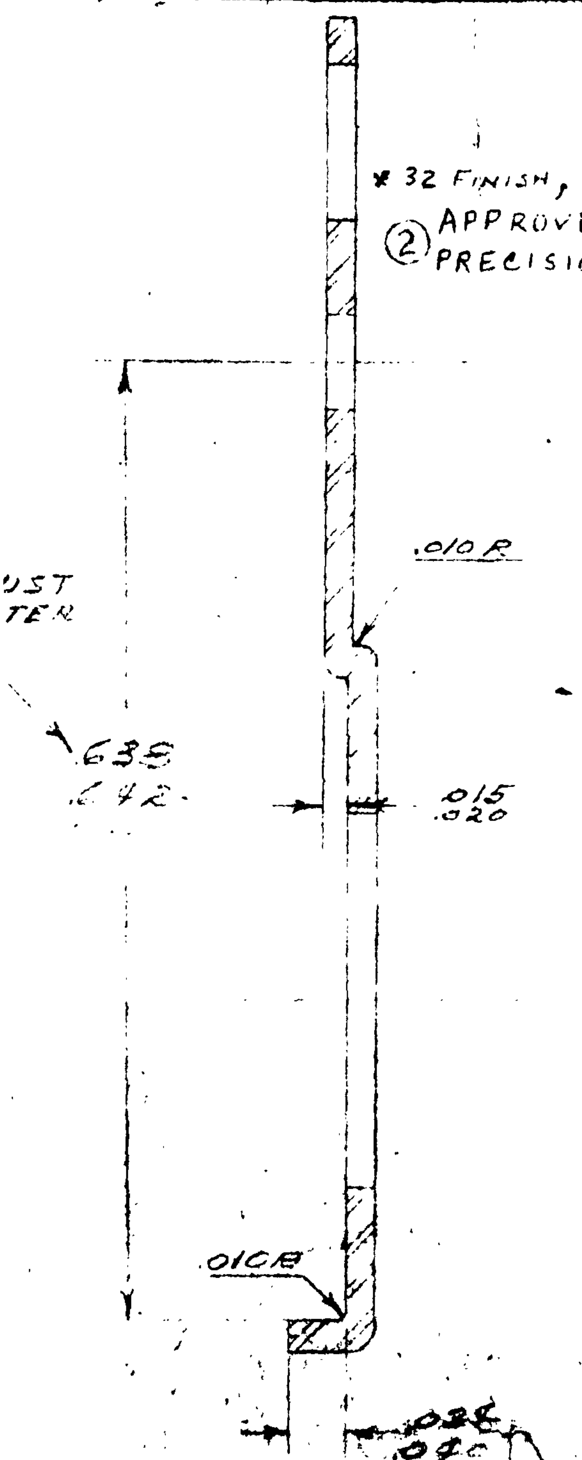
DRAWN BY C. BUSH 8-21-56 | SCALE 5 X | PRINT DISTRIBUTION

MATERIAL & DESCRIPTION	PART	CODE	FIN.	LBS. REQ. PER 1,000	B No. 70-02699
.020 THK. NICKEL SILVER	1		*		
.020 THK. HALF HARD BRASS	2		32		

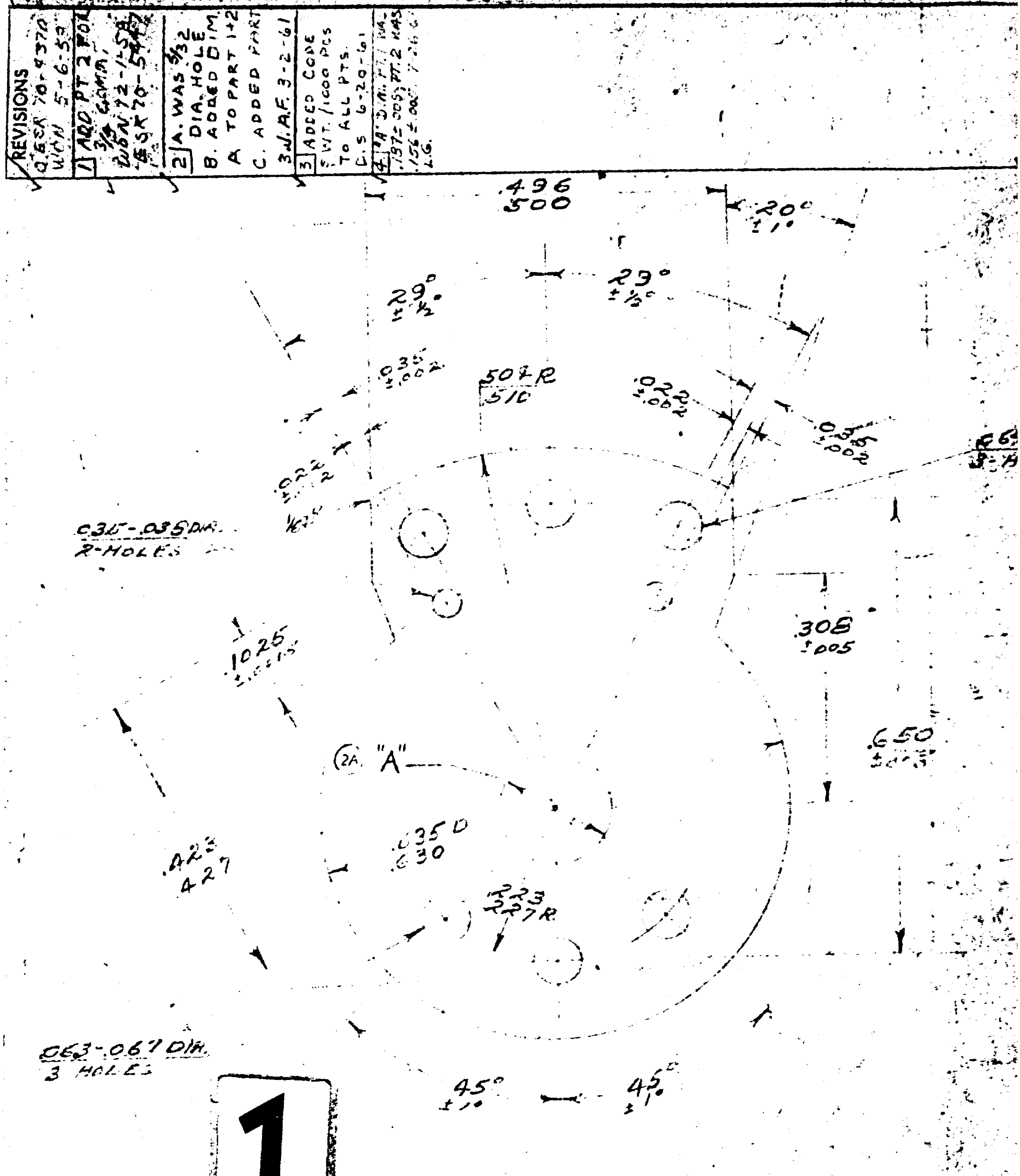
Issue	CHECKED
o	APPROVED ESR 20-4370 WON 5-6-58
1	ADD PT. 2 FOR 3/4 COMM. WON 11-28-58
2	ADDED NOTE JAF 4-25-60

* 32 FINISH, GOLD FLASH .000005-.000010

(2) APPROVED VENDOR FOR PLATING: PRECISION ELECTRO-PLATING CO.



2



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MULT. = .687

MALLORY Main Office: Indianapolis, Ind., U.S.A.	SCALE: 6X	TITLE: BASE 1/4 INCH CONTROL	70-02700	SUB
DRAWN C.B. APPR. DATE 6-2-61	DIST.	240C	DIVISION	DO NOT SCALE - ALL DIMENSIONS IN INCHES - DIMENSIONS BEFORE PLATING

	PART	A	MATERIAL - DESCRIPTION	CODE	FINISH	WT/M
2B	1	.203 ±.003	3/64 SILICONE GLASS	Z-0016		1.91
	2	.203±.003	3/64 XXXP PHENOLIC	Z-0017		1.47
2C	3	.203±.003	3/64 XXXP PHENOLIC	Z-0017		1.47

*Material must withstand continuous operation at 250°C e.g., Mica Insulator G-7 No. 6090

.064-.067 DIA. 3-HOLES

Best Available Copy

2

70-02700

FOR:

VA 66 OE

REVISIONS	MALLORY	DRAWN BY: C BUSH DATE: 4-2-57	TITLE: R.H. TERMINAL 3/4 INCH. CONTROL	70-02691
0 ESR 70-4370 5-6-58 WON	Main Office: Indianapolis, Ind., U.S.A.	APPR.	DIST.	UNLESS OTHERWISE SPECIFIED DECIMALS ± .005 — FRACTIONS ± 1/ DO NOT SCALE – ALL DIMENSIONS INCHES DIMENSIONS BEFORE PLAT
	SCALE: 8 X			

PART	ITEM	QUAN.	MATERIAL - DESCRIPTION	CODE	FINISH	WT
1			.015 H.H. BRASS		*	
2			.015 H.H. BRASS		32	

1 ADD PT 2 FOR 3/4 COMP WON 11-28-58 SR 70-5947

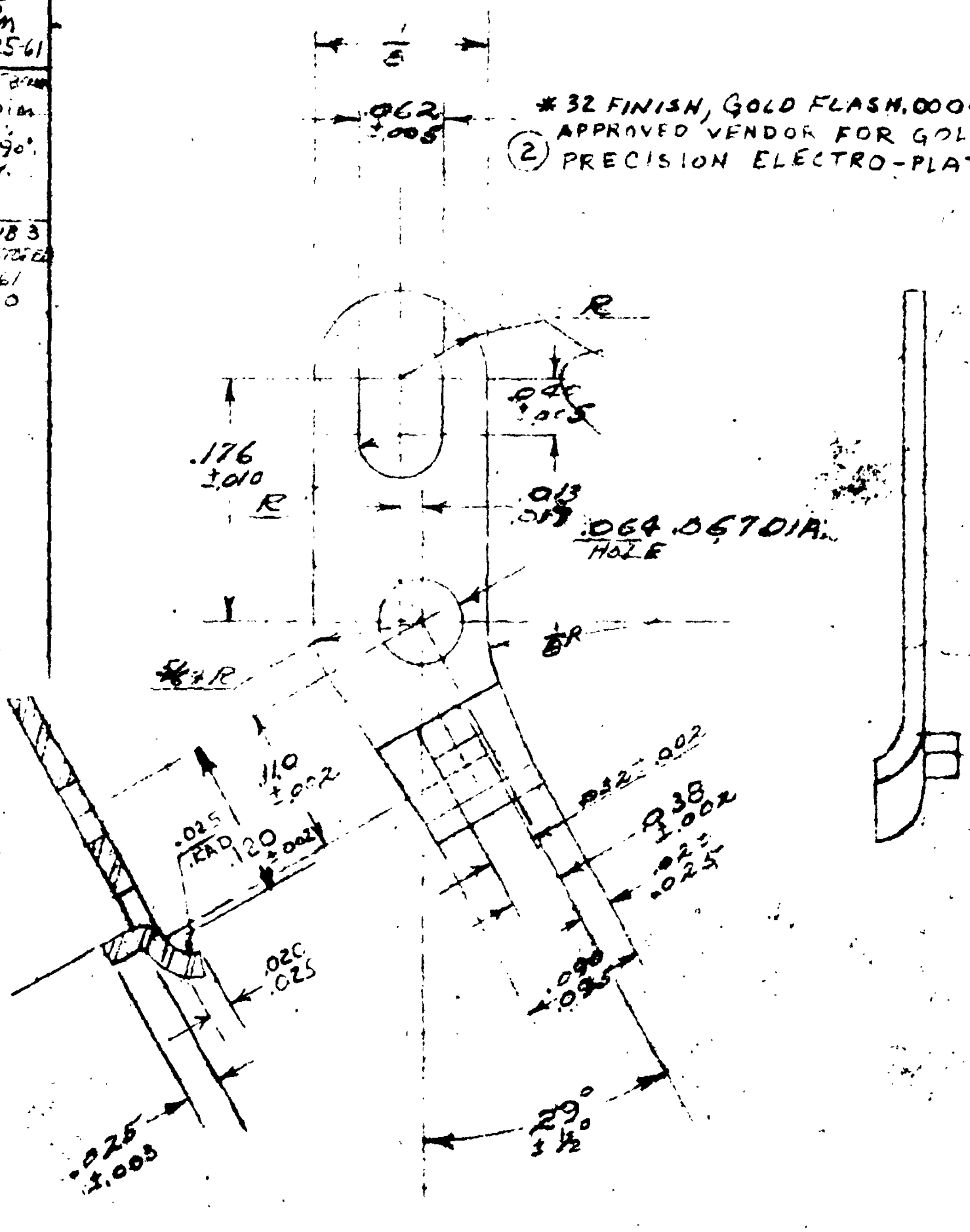
2 ADDED NOTE JAF 4-25-60 ECN 70-7832

3 ADD .015 BEND DIM (3) WON 5-25-61

4 REMOVE .020-.025 DIM ADD .025 ± .00 .050-.055 ± 90° FOR CLARITY. L.G. 6-13-61 NO MEMO

5 REMOVED SUB 3 & 4 NOTES. RESTORED SUB 2. 7-19-61 L.G. NO MEMO

* 32 FINISH, GOLD FLASH .000005-.00001
(2) APPROVED VENDOR FOR GOLD PLATING PRECISION ELECTRO-PLATING CO.



FOR:

70-02691

VA6509

REVISIONS
0 ESR 70-4375 WON 5-6-58
1 ADD PT 2 FOR 3/4 IN Comm. WOW 11-23-58 ECK 70-5997
2 ADDED NOTE JAF 4-25-60
ECN 70-7832
3 ADD .015 BEND DIM WON 5-25-61
4 REMOVE .015 & .020-.025 DIM ADD .025 ±.005 & .050-.055 DIM FOR ... 6-13-61
5 REMOVED SUB 3 & 4 NOTES, RESTORED SUB 2 7-19-

MALLORY
Main Office: Indianapolis, Ind., U.S.A.

DRAWN BY: C BUSH
DATE: 9-2-57
SCALE: 8 X
APPR.
DIST.

TITLE: L.H. TERMINAL 3/4 INCH CONTROL

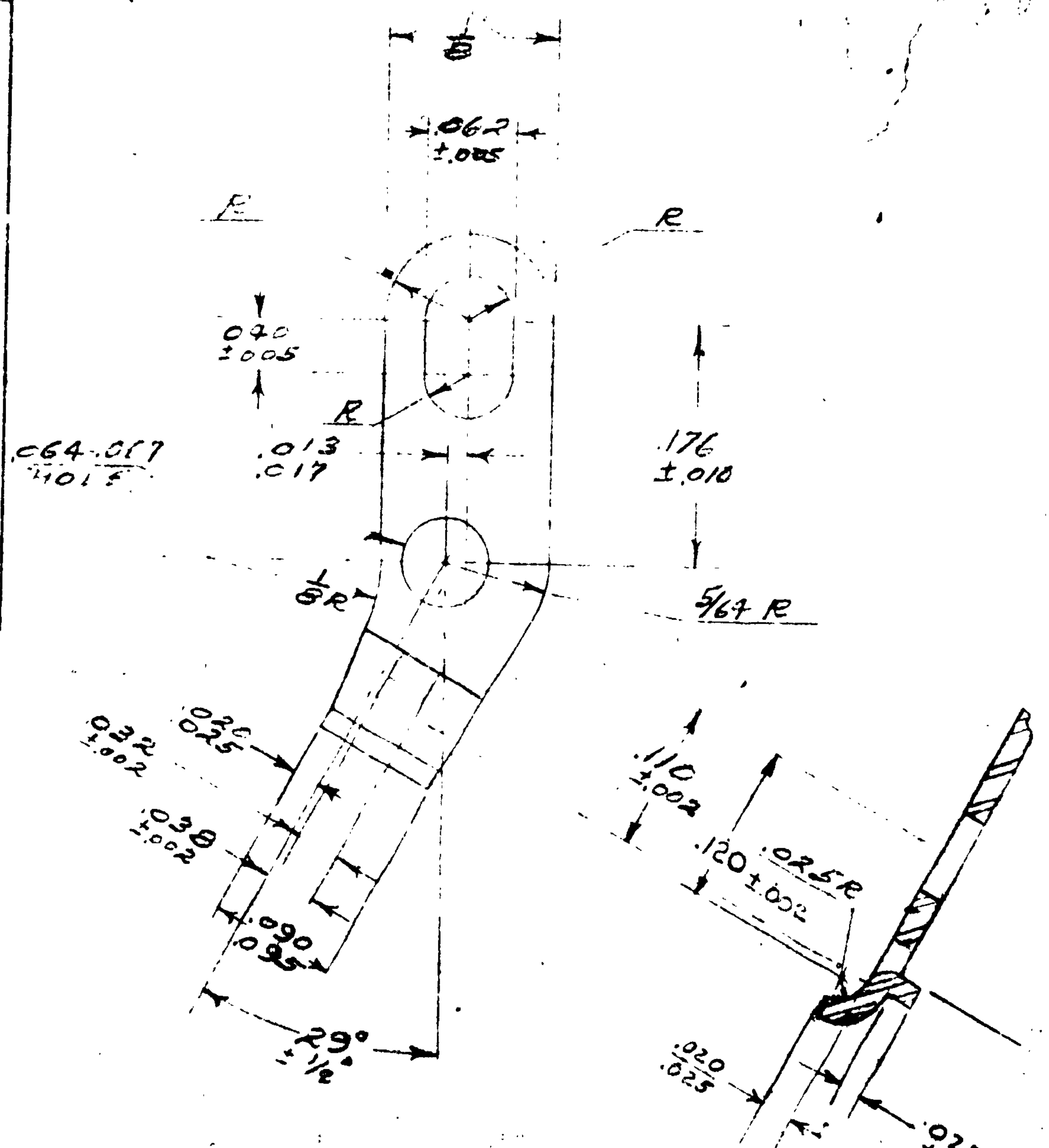
70-0269

UNLESS OTHERWISE SPECIFIED DECIMALS ± .005 — FRACTIONS ± 1/64
DO NOT SCALE - ALL DIMENSIONS INCHES - DIMENSIONS BEFORE PLATING

PART	ITEM	QUAN.	MATERIAL - DESCRIPTION	CODE	FINISH	WT/
1			.015 H.H. BRASS		*	
2			.015 H. H. BRASS		32	

* 32 FINISH, GOLD FLASH .000005-.000010

(2) APPROVED VENDOR FOR GOLD PLATING: PRECISION ELECTRO-PLATING CO.



FOR:

F-306

KR 6510

REVISIONS
ESR 70-4978 WON 5-6-58
[1] ECN 70-6454 L.G. 5-19-58 TL WAS H.H. CLASS 32 PL.
[2] ADD PT 2 FOR 3/4 COMM. WON 11-28-58 ESR 70-5997
[3] ADD PT 3 for 3/4 WW CLASS 9 SG WON 6-29-62

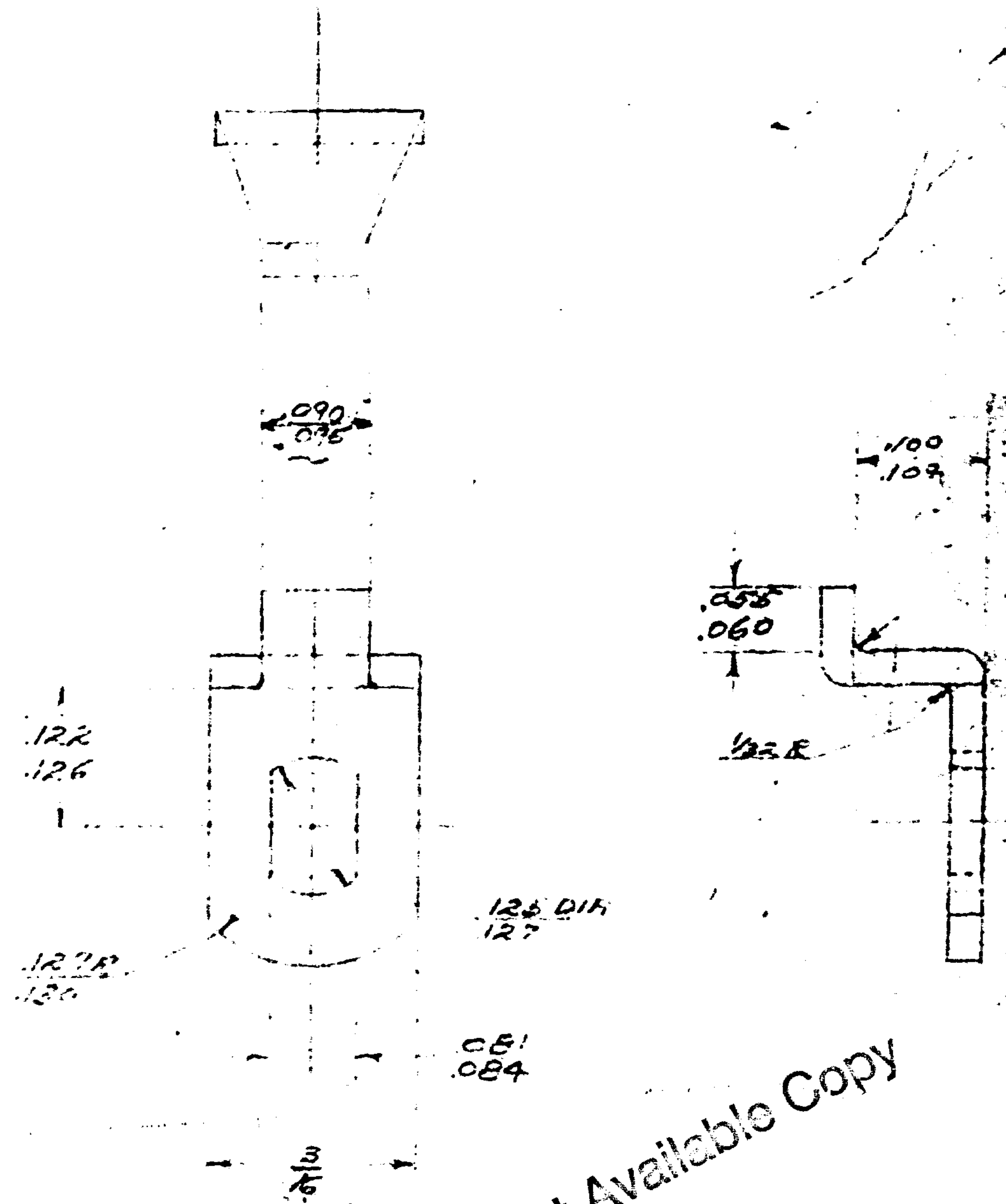
MALLORY
Main Office: Indianapolis, Ind., U.S.A.

DRAWN BY: C BUSH
DATE: 3-2-56
SCALE: 6X
APPR.
DIST.
TITLE: STOP 3/4 INCH CONTROL
200C

70-02693

UNLESS OTHERWISE SPECIFIED DECIMALS ± .005—FRACTIONS ± 1/64 DO NOT SCALE – ALL DIMENSIONS IN INCHES DIMENSIONS BEFORE PLATING

PART	ITEM	QUAN.	MATERIAL - DESCRIPTION	CODE	FINISH	WT/M.
1			.030 THK. TYPE 302 S.S. 1/4 HARD.		—	
2			.032 THK. C.R. STEEL		22	
3			.032 THK. C.R. STEEL		24C	



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FOR:

F-386—Rev.-3-54

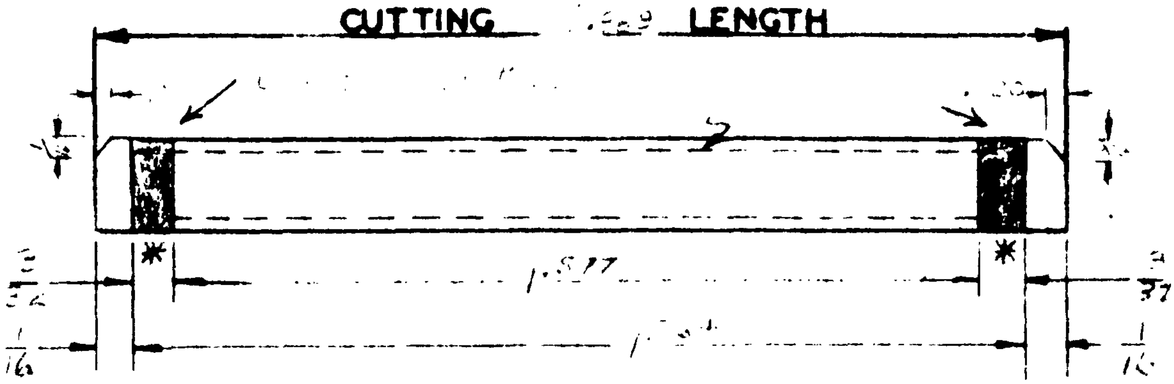
DATE [illegible]
BY [illegible]

P. R. MALLORY & CO. INC.
INDIANAPOLIS, INDIANA

W.S.# [illegible]

☐ ~~RESISTOR~~
☐ ~~RHEOSTAT~~
☒ POTENTIOMETER

CODE [illegible]



WINDING	RESIS-TANCE	LENGTH	WIRE SIZE	KIND OF WIRE*	LBS. PER UNIT	TURNS PER IN	GEAR RATIO A	B	C	D
SHORT OUT	—	[illegible]								
1st	20000	[illegible]	[illegible]	[illegible]	[illegible]	406	[illegible]	37	72	24
SHORT OUT	—	[illegible]								

TERMINAL A

TERMINAL B

CORE STRIP 72-02[illegible]

ONE STRIP MAKES PCS.

REMARKS CONSTANT = .097
COILS MUST BE CURED AT 225°C FOR 4 HRS AFTER WINDING AND SILVERING. NOTCH AT POINTS* AND PUT FIBERTITE ON THIS EDGE ONLY. COILS SHOULD BE INSPECTED UNDER A MICROSCOPE FOR GOOD WORKMANSHIP.

FOR ASSEMBLY SEE

CUT CORE PER

RESISTANCE TOLERANCE

+ 5 % − 5 %

RESISTANCE LIMITS

HIGH 21,000

LOW 19,000

REVISIONS

E.O.R. 70-3134

RELEASED FOR PROD. J.A.F. 4-3-61

W.S.#

DATE 10-26-57
BY W NELSON

P. R. MALLORY & CO. INC.
INDIANAPOLIS, INDIANA

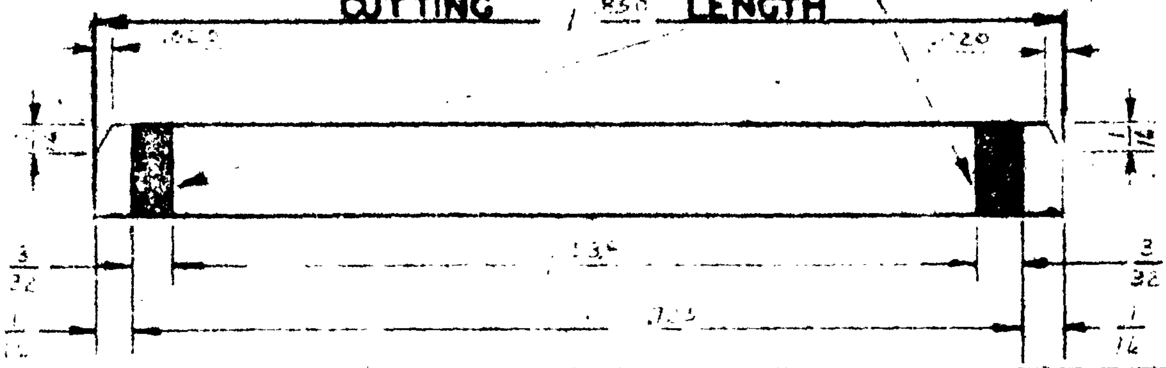
W.S.# 2241

CODE S 3 P

~~RESISTOR~~
~~RHEOSTAT~~
■ POTENTIOMETER

USE DUPONT #4688 SILVER (ONLY)

CUTTING 1.850 LENGTH



WINDING	RESISTANCE	LENGTH	WIRE SIZE	KIND OF WIRE	LBS. PER UNIT	TURNS PER IN	GEAR RATIO A	B	C	
SHORTING		3/32								
1ST	3	[illegible]	[illegible]	[illegible]	.00085	70	42		IDLER	2
SHORTING		3/32								

TERMINAL A

TERMINAL B

CORE STRIP 76-525 [illegible]

ONE STRIP MAKES PCS.

REMARKS [illegible]

"COILS MUST BE CURED AT 225°C. FOR 4 HR. AFTER WINDING + SILVERING."

FOR ASSEMBLY SEE

CUT CORE PER

RESISTANCE TOLERANCE

+ 5 % — 5 %

RESISTANCE LIMITS

HIGH 3.15

LOW 2.85

REVISIONS

0 ESP 7-7[illegible]

W.S.# 2241

VA 8508

DATE 4-15-58
BY [illegible]

P. R. MALLORY & CO. INC.
INDIANAPOLIS, INDIANA

W.S.# 2187

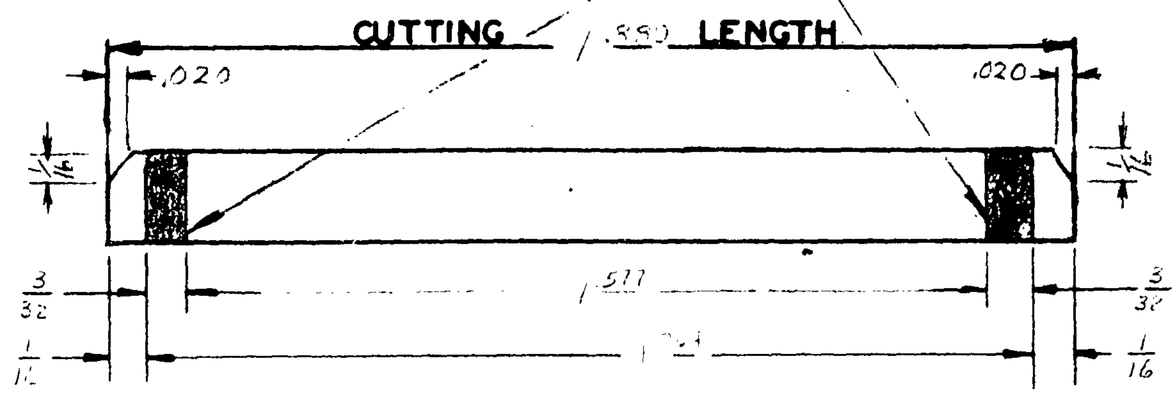
#10[illegible]

~~☐ RESISTOR~~
~~☐ RHEOSTAT~~
☐ POTENTIOMETER

USE DUPONT #6838 SILVER (ONLY)

CODE S25,000P

MAT. .032 TK.



WINDING	RESISTANCE	LENGTH	WIRE SIZE	KIND OF WIRE	LBS. PER UNIT	TURNS PER IN	GEAR RATIO A	B	C	D
SHIP[illegible]		[illegible]								
[illegible]	25[illegible]	1.511	[illegible]	KARMA	.00009	425	150	42	75	41
SH[illegible]		[illegible]								

TERMINAL A

TERMINAL B

CORE STRIP 70-02812-1

ONE STRIP MAKES PCS.

REMARKS [illegible]

COIL MUST BE CURED AT 225 °C FOR 4 HR., AFTER WINDING & SILVERING.

FOR ASSEMBLY SEE

CUT CORE PER

RESISTANCE TOLERANCE

+ 5 % — 5 %

RESISTANCE LIMITS

HIGH 26,250

LOW 23,750

REVISIONS [illegible]

W.S.# 2187

DATE [illegible]
BY [illegible]

P. R. MALLORY & CO. INC.
INDIANAPOLIS, INDIANA

W.S.# [illegible]

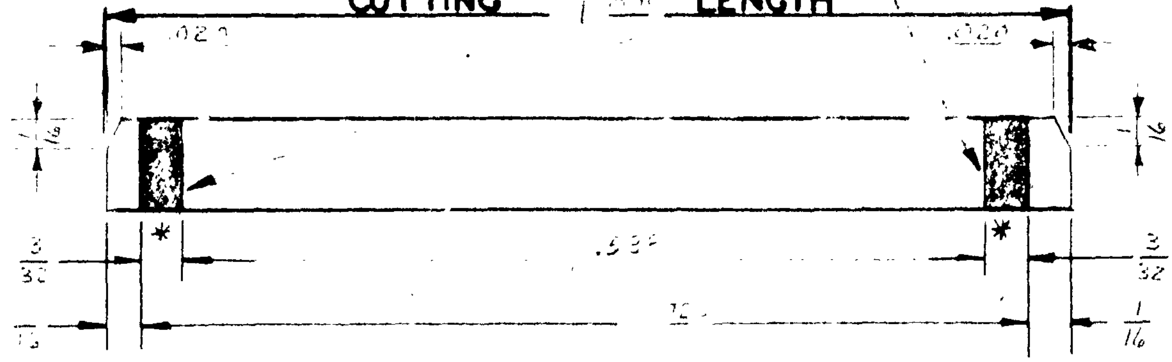
#106

~~RESISTOR~~
~~RHEOSTAT~~
☒ POTENTIOMETER

CODE [illegible]

USE [illegible] #6338 [illegible]

CUTTING [illegible] LENGTH



WINDING	RESISTANCE	LENGTH	WIRE SIZE	KIND OF WIRE	LBS. PER UNIT	TURNS PER IN	GEAR RATIO A	B	C	D
SHORTOUT	------	3/32								
1ST	[illegible]	1.340	[illegible]	# [illegible] ALLOY	.0065[illegible]	[illegible]	44		[illegible]	24
SHORTOUT		3/32								

TERMINAL A

TERMINAL B

CORE STRIP [illegible]

ONE STRIP MAKES PCS.

REMARKS "COIL" MUST BE [illegible]
[illegible] FOR [illegible] AFTER WINDING
+ SILVERING. NOTCH AT POINT *
AND PUT [illegible] ON THIS [illegible]
ONLY. COILS SHOULD BE
INSPECTED UNDER + MICROSCOPE
FOR GOOD WORKMANSHIP.

FOR ASSEMBLY SEE

CUT CORE PER

RESISTANCE TOLERANCE

\+ 5 % — 5 %

RESISTANCE LIMITS

HIGH 10.5

LOW 9.5

REVISIONS

0 ECN 70-[illegible]
1 [illegible]
2 WIRE [illegible]
3 ADDED MORE [illegible]

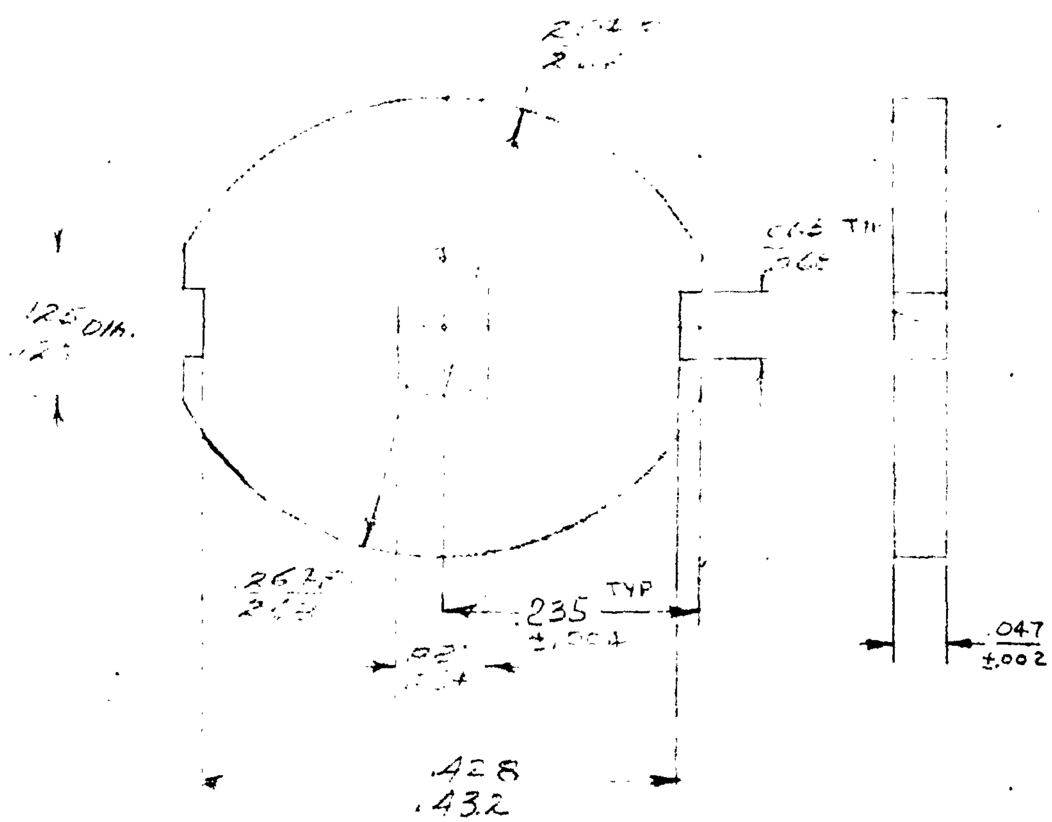
W.S.# 2145

MULT. - 5/8 VA C512

REVISIONS	MALLORY Main Office: Indianapolis, Ind., U.S.A.	DRAWN BY:	TITLE: ROTOR	70-02694
0 ESR 71-4570	SCALE:	APPR.	DIST.	UNLESS OTHERWISE SPECIFIED DECIMALS ± .005—FRACTIONS ± 1/ DO NOT SCALE - ALL DIMENSIONS INCHES-DIMENSIONS BEFORE PLATI
1 ADD PT 3 FOR 3/4 COMM. WON 11-28-58 FSR 70-5997				
ADDED CODE & WT/1000 PCS. TO PTS. 1 & 3 D S 6-21-61				

PART	ITEM	QUAN.	MATERIAL - DESCRIPTION	CODE	FINISH	WT/
1			3/64 ±.002 SILICONE GLASS *	Z-0014		1.0
2			3/64 ±.002 TEFLON GLASS REINFORCED			
3			3/64 ±.002 XXXP PHENOLIC	Z-0015		.79

* MATERIAL MUST WITHSTAND CONTINUOUS OPERATION AT 250°C e.g. MICA INSULATOR G-7 No. 6030



FOR:

YA 6543

REVISIONS
O EER 70 4370 W.O.N 5-6-58
1/ECN-70-4434 LENGTH WAS 2.000-2.004 L.G. 5-19-58
2/ECN 70-4466 1.593±.003 WAS 1.550/1.555. L.G. 5-21-58
3 .065-.070 WAS 1/16 .300-.303 WAS .309-.312 L.G. 6-6-58 ECN 70-4541
4 ADD PT 2 FOR 3/4 IN COMM W.O.N 11-28-58 ECN 70-5997
5 ADDED NOTE JAF 3-21-60 ECN 70-7695

MALLORY
Main Office: Indianapolis, Ind., U.S.A.

DRAWN BY: C. BUSH
DATE:
SCALE: 2X
APPR.
DIST.

TITLE: INSULATOR 3/4 INCH CONTROL COIL

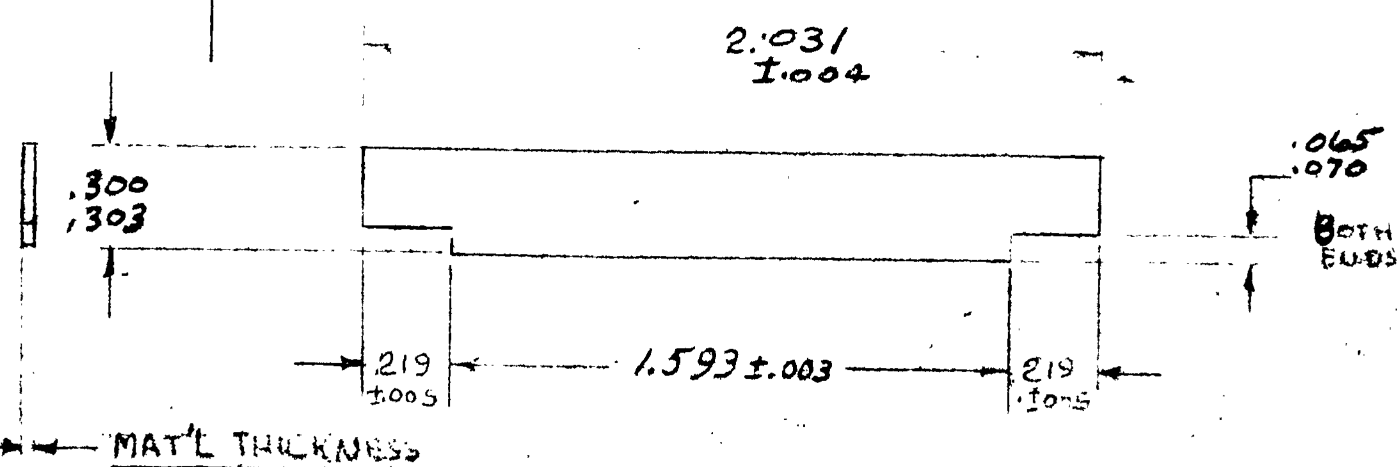
70-02695

UNLESS OTHERWISE SPECIFIED DECIMALS ± .005—FRACTIONS ± 1/… DO NOT SCALE - ALL DIMENSIONS INCHES, DIMENSIONS BEFORE PLATING

PART	ITEM	QUAN.	MATERIAL - DESCRIPTION	CODE	FINISH	WT/
1			.010 THICK SILICONE GLASS	*		
2			.010 NYLON BASE PHENOLIC			

* NOTE MATERIAL MUST BE LAMINATED WITH MATTING AT 45° TO FACILITATE FORMING. MUST WITHSTAND CONTINUOUS OPERATION AT 250°C, e.g. MICA INSULATOR G-7 No. 6030.

(5) MUST WITHSTAND A 400V.D.C. PER MIL, DIELECTRIC TEST.



FOR:

F-386 Rev. -3-54

V.I. 6574

REVISIONS	MALLORY Main Office: Indianapolis, Ind., U.S.A.	DRAWN BY: C. B. DATE:	TITLE: INSULATOR COVER	70-02696
ESN 70-4380	SCALE: 4 X	APPR.	DIST.	UNLESS OTHERWISE SPECIFIED DECIMALS ± .005—FRACTIONS ± 1/ DO NOT SCALE - ALL DIMENSIONS INCHES DIMENSIONS BEFORE PLATING

PART	ITEM	QUAN.	MATERIAL - DESCRIPTION	CODE	FINISH	WT
1			.015 SILICONE GLASS	*		
2			.015 NYLON BASE PHENOLIC			

REVISIONS:

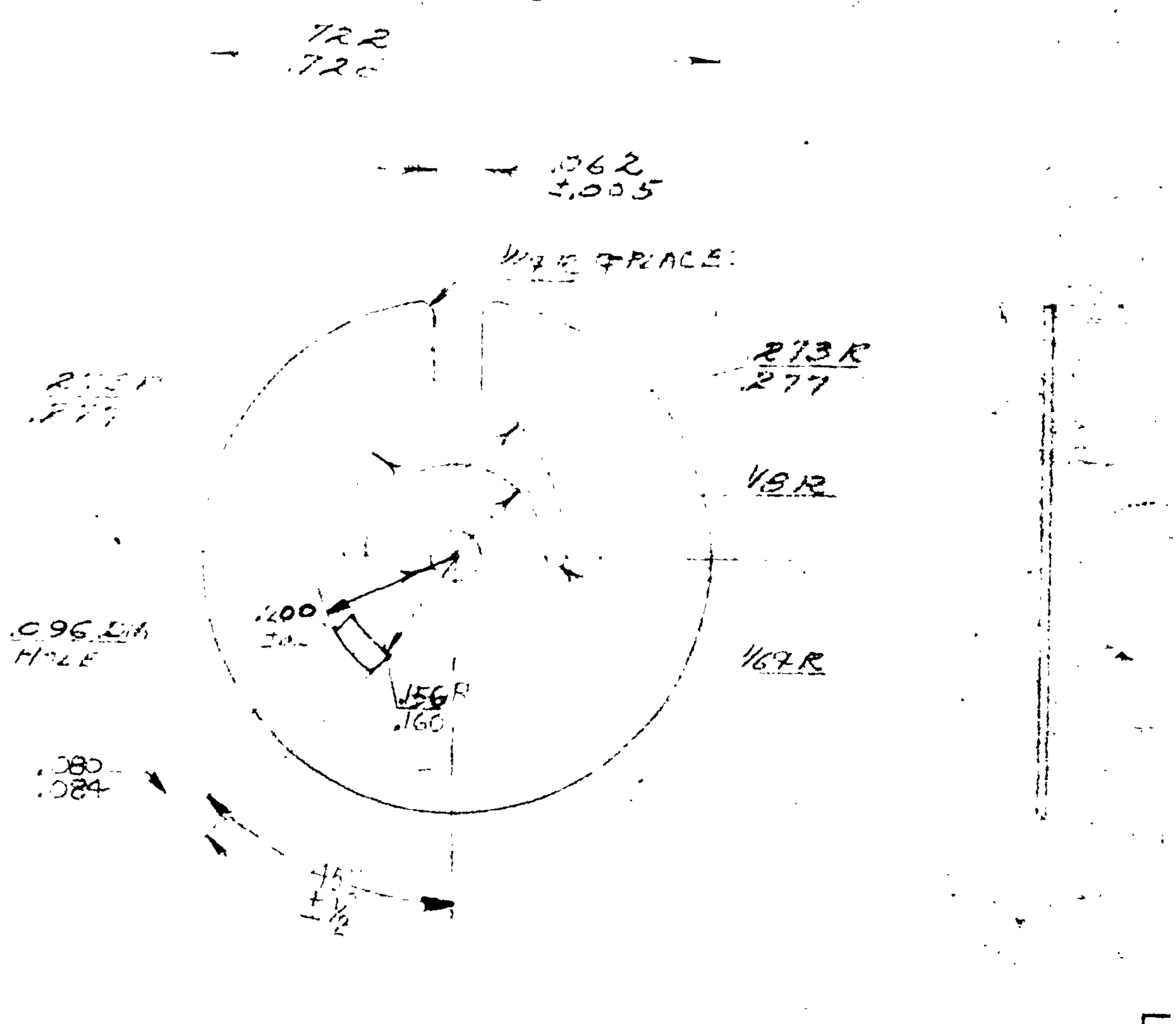
1 CHANGED THK. ... ECN 70-4922

2 ... ECN ... 4862

3 ADD PT 2 FOR 3/4 COMM. ... 11-28-58 ESF 70-5447

4 .200 DIM WAS .234 LG-1-28-59 ECN-70-5726

* MATERIAL MUST WITHSTAND CONTINUOUS OPERATION AT 250°
& SIMICA INSULATOR G-7 NO. 609



FOR:

F-386—Rev.-3-54

VA 6.7.3.3

REVISIONS

0/ ESR 7? - ?? 0 ...
1/ REVISED TO ... 6-9-58 ... -70-4551
2/ ADD PT 2 FOR 3/4 COMM WON 11-28-58 ESR 70-5997
3/ CHANGED .155 & .167 ... .159 .171 ... WON 1-16-59 ECN 70-5665
4/ .167-.171 CHANGE .159-.155-.022-.026 ... LG. 1-28-59 ECN-70-5128

MALLORY
Main Office: Indianapolis, Ind., U.S.A.

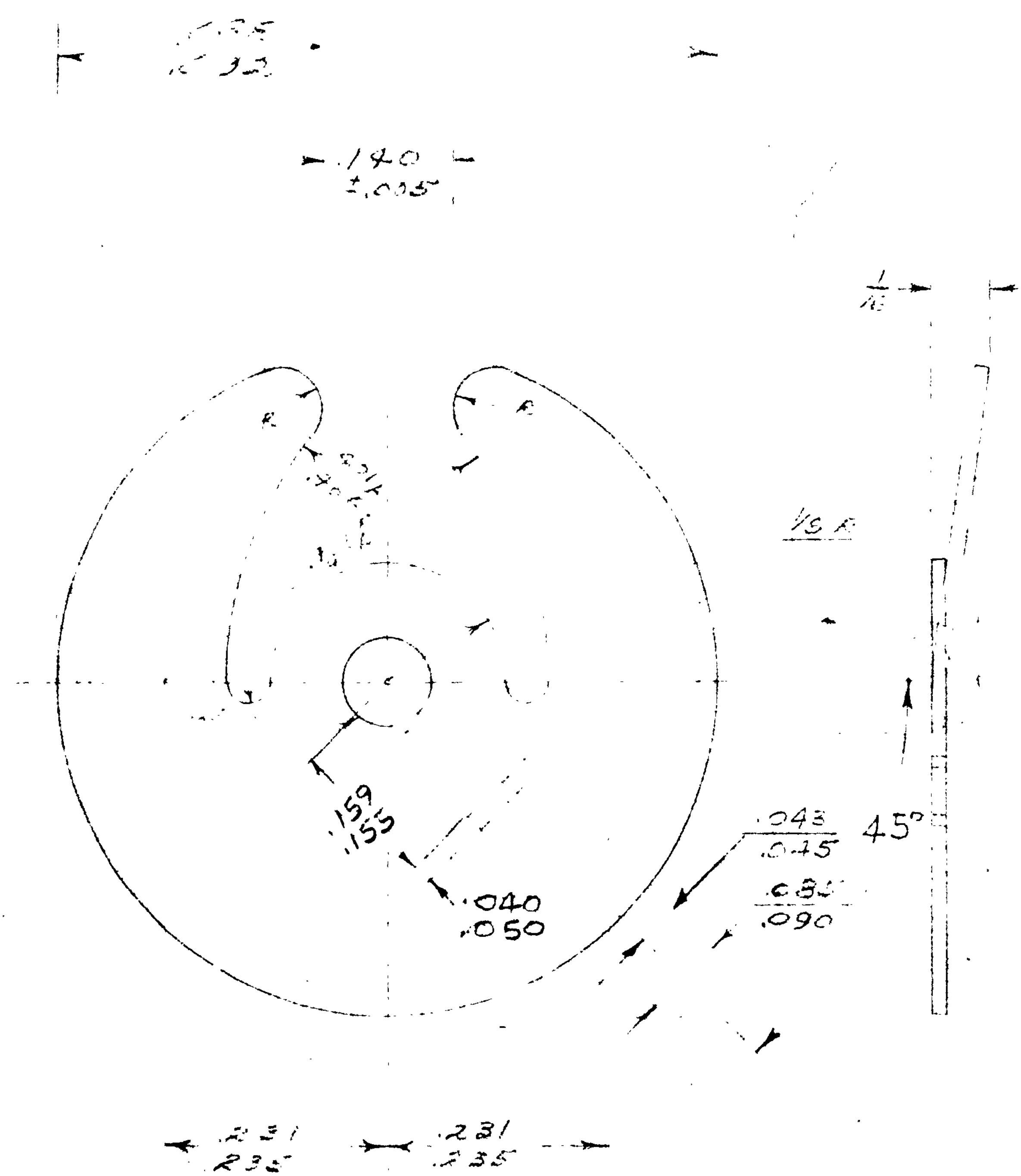
DRAWN BY: C BUSH
DATE: 1-7-56
SCALE: 6 x
APPR.
DIST. 91

TITLE: SPRING 3/4 INCH CON CONTROL

70-02689

UNLESS OTHERWISE SPECIFIED DECIMALS ± .005—FRACTIONS ± 1/64
DO NOT SCALE - ALL DIMENSIONS IN INCHES-DIMENSIONS BEFORE PLATING

PART	ITEM	QUAN.	MATERIAL - DESCRIPTION	CODE	FINISH	WT/M
1			SAE 302 HALF HARD STAINLESS STL		—	
2			.015 SPRING TEMP BLUE STEEL			



.096 DIA HOLE

FOR:

F-386—Rev. 3 54

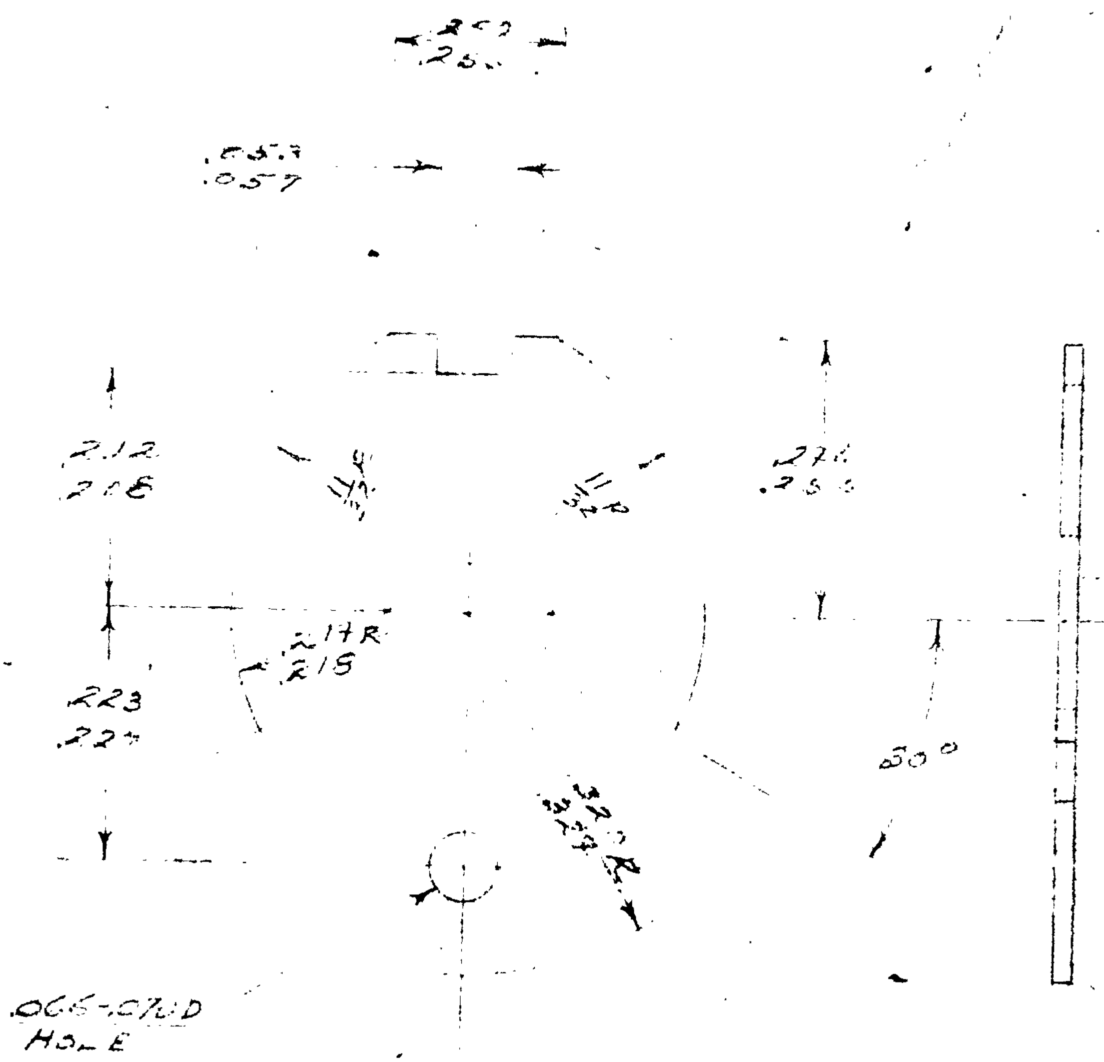
MULT.-

[illegible]

REVISIONS	MALLORY Main Office: Indianapolis, Ind., U.S.A.	DRAWN BY: E GUSH DATE: 1-7-57	TITLE: SPACER 3/4 INCH CONTROL 240C	70-02690
0 ESK 70-4370 WCN 5-6-58	SCALE: 6X	APPR.	DIST.	UNLESS OTHERWISE SPECIFIED DECIMALS ± .005—FRACTIONS ± 1/ DO NOT SCALE – ALL DIMENSIONS INCHES DIMENSIONS BEFORE PLATING
1 ADD PT 2 FOR 3/4 COMM WON 11-28-58 R 73-5447				

PART	ITEM	QUAN.	MATERIAL - DESCRIPTION	CODE	FINISH	WT/
1			.015" SILICONE GLASS *			
2			.015 XXXP PHENOLIC			

*MATERIAL MUST WITHSTAND CONTINUOUS OPERATION AT 250°C e.g. MICA INSULATOR G-7 No. 6090



FOR:

REVISIONS
PREVIOUS MEMOS 76-4370, 4470, 4561, 4601, 4901, 4964, 5201, 5224, 5508, 5644, 5751 - LG, -2-9-57
11 ADD PT. 3 FOR BENDIX • # 76-020615 - 2-9-59 - LG, ESR-70-5817
12 ADD PT 9 FOR NATIONAL [illegible] 2-25-[illegible] ESR [illegible] 5913
13 ADD PT 7 FOR SYLVANIA ELEC W.O.N. 4-10-57 ESR 70-6191
14 CHANGED AS [illegible] PT 10 [illegible] 3-29-59 E.C.N. 70-6[illegible]
15 CHANGED FMS FROM .62 & PT 10 W.O.N. 6-19-59 E.C.N. 70-6615
16 [illegible] 365 [illegible] NG-2-23-6[illegible]
17 ADD PT. 11 & HURLETRON INC. W.O.N. 5-28-62

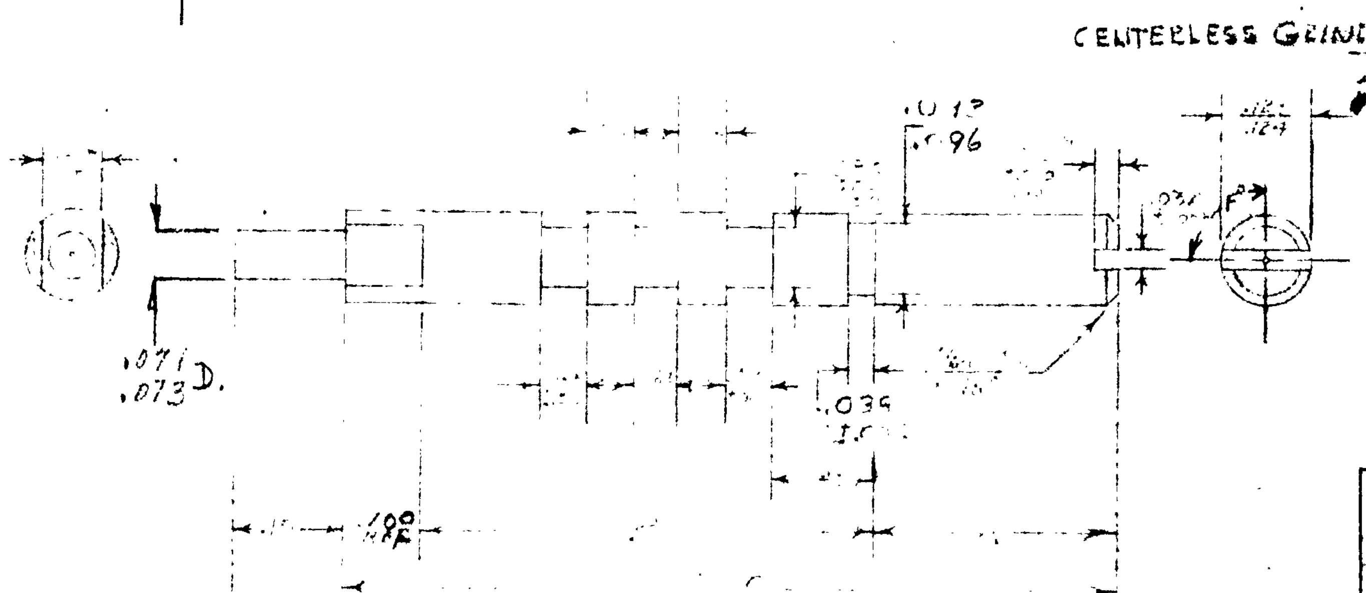
MALLORY
Main Office: Indianapolis, Ind., U.S.A.

DRAWN BY:
DATE:
SCALE:
APPR.
DIST. 91
TITLE:

70-0268[illegible]

UNLESS OTHERWISE SPECIFIED DECIMALS ± .0[illegible] FRACTIONS ± .0[illegible]
DO NOT SCALE - ALL DIMENSIONS INCHES - DIMENSIONS BEFORE PLATI[NG]

PART	A	[illegible]	[illegible]	[illegible] F.M.	MATERIAL - DESCRIPTION	F°	[illegible] F.M.	CODE	FINISH	WT/
[illegible]	.344	.614	1.05	[illegible]	303 ST. STEEL	—	-	72366	—	4.[illegible]
2	.719	.614	1.433	1½		—			—	[illegible]
3	.515	.614	1.229	—	"	—	¾		—	4.[illegible]
4	.891	.614	1.605	—	" " "	—	1⅛	"	—	6.[illegible]
5	.219	.614	.935	⅝	⅛ C.R.S. ROD	—	—	69395	22	3.7[illegible]
6	.594	.614	1.318	1	#303 ST. STEEL	—	—	72366	—	4.8[illegible]
7	.765	.614	1.479	—	" "	—	1	"	—	5.[illegible]
8	.265	.614	.979	—	" " "	-	½	"	—	3.8[illegible]
9	.390	.614	1.104	—	" " "	-	⅝	"	—	4.1[illegible]
10	.395	.614	1.109	—	" " "	45°	.65	"	—	4.1[illegible]
11	.094	.614	.808	½	⅛ C.R.S. ROD	-	—	69395	22	3.[illegible]



FOR:

F-386—Rev.—3-54

P. R. MALLORY & CO., Inc.
INDIANAPOLIS, INDIANA, U. S. A.

TITLE: EYELETS

DO NOT SCALE. ALL DIMENSIONS ARE IN INCHES. TOLERANCES UNLESS OTHERWISE SPECIFIED: DECIMALS ± .003, FRACTIONS ± .005, ANGLES ± 1½°. DIAMETERS CONCENTRIC WITHIN .004 TOTAL INDICATOR READING. ALL DIMENSIONS SHOWN ARE BEFORE PLATING.

DRAWN BY: [illegible]
SCALE:
PRINT DISTRIBUTION: 403

A- 141540

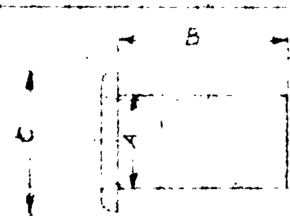
Pt No.	A	B	C	DESCRIPTION	MAT	FIN
1	.152 ±.002	.312 ±.005	.245 ±.005	MAKE FROM [illegible] USMC SE 510	B	62
2	.165-.158 ±.002	.375 ±[illegible]	.305 ±.005	[illegible] 5345	B	62
3	.163 ±.002	.415 ±.005	.300 ±[illegible]	[illegible] A 4[illegible] [illegible] EQU.	B	[illegible]
4	.267 ±.005	.132 ±[illegible]	.363 ±[illegible]	USMC 3[illegible] [illegible]	C	[illegible]
5	9/64	1/8	13/[illegible]	SAME [illegible]	C	[illegible]
6	.121 ±.002	.219 ±[illegible]	.200 ±.005	USMC SE 47 OR EQU.	B	[illegible]
7	.094 [illegible]	7/[illegible]	.[illegible]45	U[illegible]	E	-
8	.183 ±.002	.125 ±.005	.290 ±.005	USMC [illegible]	E	[illegible]
9	.158 ±.002	.210 ±[illegible]	.250 ±.005	STIMPSON A 253 [illegible]	B	62
10	.150-.145 ±.002	.353 ±[illegible]	.218 ±.005	[illegible] EACH	B	33
11	.089 ±.002	.093 ±.005	.150 ±.005	USMC SE 35 OR EQU.	B	62
12	.089 ±.002	.125 ±.005	.150 ±[illegible]	[illegible] 24	B	24
13	.089 ±.002	.125 ±.005	.150 ±.005	"	B	[illegible]
14	.089 ±.002	.125 ±.005	.150 ±[illegible]		B	65
15	.152 ±[illegible]	.312 ±.005	.245 ±.005	MAKE FROM [illegible] USMC SE 510	B	65
[illegible]	-	-	-	OBSOLETE	-	-
17	.158 ±.002	.210 ±[illegible]	.250 ±.005	MAKE FROM [illegible] A 253	B	44
18	.155	[illegible]/64	.29[illegible] ±.005	- -	E	
19	.152 ±.002	.125 ±.005	.245 ±.005	MAKE [illegible] USMC SE 54	B	[illegible]
20	.150-.145 ±.002	.353 ±.005	.218 ±.005	[illegible]	B	32
21	.150-.145 ±[illegible]	.353 [illegible]	.218	"	B	34
22	.152 ±[illegible]	.312 ±.005	.245 ±.005	MAKE [illegible]	B	31
23	.085 ±.004	11/64	5/32	[illegible] USMC 5000	B	62
24	-	-		[illegible] 64 [illegible]	-	-
25	.121 ±.002	.219 ±.005	.200 ±.005	USMC SE 47	B	32
26	.183 ±.002	.125 ±.005	.290 ±[illegible]	SAME AS [illegible] USMC SE [illegible]	B	-
27	.158 ±.002	.210 ±.005	.250 ±.005	[illegible] STIMPSON A 253	B	[illegible]
28	.232 .234	23/32	5/16	STIMPSON A 873	B	63
29	.183 ±.002	.156 ±.005	.290 ±.005	USMC SE 65 OR EQU.	B	62
30	.089 ±.002	.093 ±.005	.150 ±[illegible]	USMC SE [illegible] OR EQU.	B	-
31	.085 .080	11/64	5/32	SAME AS PT 23 EXC. PLATING	B	-
32	.183 ±.002	.156 ±.005	.230 ±.005	USMC SE 63 SAME AS PT 29 EXC. [illegible]	-	31
33	.160 .154	.156 ±.005	.245 ±.005	USMC SE 55 OR EQUAL	B	-
34	.124 .118	.242 .258	.194 .240	USMC SE 4F OR EQUAL	B	-
35	SAME AS PT 11 EXCEPT ADD .000005-.000010 GOLD FLASH					

Issue	CHECKED
0	APPROVED

REVISIONS

3[illegible]	[illegible] REVISED [illegible] 4-[illegible]
38	ADD PT. 33 FOR RESISTOR DIV. [illegible] 3-8-54
39	ADD PT. 34 FOR TIMER SWITCH [illegible] 7-18-56 [illegible]
[illegible]	Added Part 35 for [illegible] [illegible]

FRANKFORT
[redacted]



FINISH:
#24 CAD. .0002-.0003
#31 SILVER .00025 NOM. [illegible]
#32 SILVER .0001 NOM.
#34 SILVER .0002-.0003
#44 NICKEL .0001 [illegible]
#63 NICKEL .0002-.0003
#65 NICKEL .0001-.0002

T
NOTE: PTS 6, 16, 20, 21 ARE [illegible]

[illegible]

A11264

P. R. MALLORY & CO., Inc.
INDIANAPOLIS, INDIANA, U. S. A.

TITLE: RIVET

DRAWN BY: PUERNER

SCALE: –

PRINT DISTRIBUTION: NO 3

DO NOT SCALE. ALL DIMENSIONS ARE IN INCHES. TOLERANCES UNLESS OTHERWISE SPECIFIED: DECIMAL ±.005, FRACTIONS ±.005, ANGLES ±1½°. DIAMETERS CONCENTRIC WITHIN .004 TOTAL INDICATOR READING. ALL DIMENSIONS SHOWN ARE BEFORE PLATING.

A-13363

PART	A	MATERIAL	CODE	FINISH	NOTES
1	3/32	BRASS	Δ	31	#1
2	–	MADE FROM PT #1 STRIP + REPLATE #32		32	#4
3	5/64	BRASS	Δ	31	#1
4	7/64	BRASS	Δ	–	
5	11/64	BRASS	Δ	31	#1
6	3/16	BRASS	Δ	31	#1
7	1/8	BRASS	Δ	31	#1
8	3/32	BRASS MAY BE MADE FROM PT 1 BY STRIPPING + REPLATING	Δ	63	#2
9	3/32	STEEL	Δ	SEE NOTE	#5
10	3/32	BRASS	Δ	34	#3
11	7/64	"	Δ	31	#1

12 Same as PT 5 except add [illegible]

Issue	CHECKED
0	APPROVED

REVISIONS

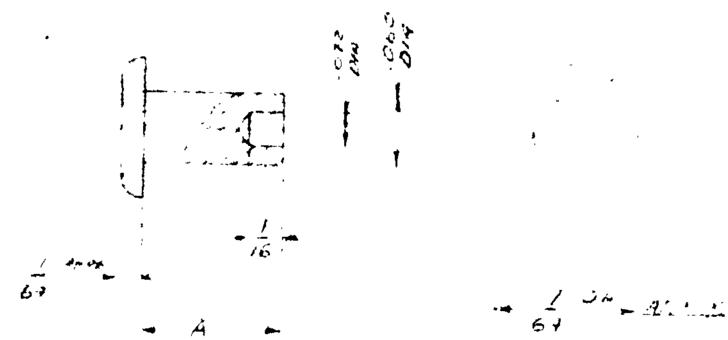
13 ✓	[illegible] 4-23-50
14	PART 4 WAS #31 FINISH A.R. 5-1-53
15 ✓	ADD PART 11 FOR TUNER A.R. 5-13-53
16	Part 12 added for [illegible]

FRANKFORT

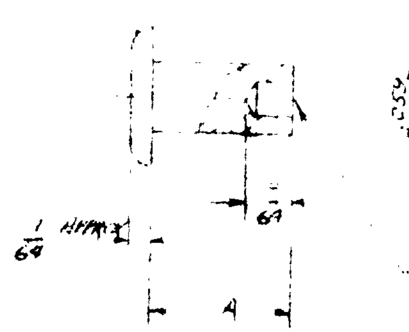
[redacted]

Δ PURCHASE FROM CHICAGO RIVET OR TUBULAR RIVET CO.

NOT STD



OPTION 1



TUBULAR STAND HOLE

OPTION #2

#5: ELECTRO TIN, CADMIUM OR ZINC
#4: #32 FINISH - SILVER PLATE .0001 THK
#3: #34 FINISH - SILVER PL .0002 - .0003 THK
#2: #63 FINISH NICKEL PLATE - .0003 MIN THK
#1: #31 FINISH SILVER FLASH PLATE
NOTES:

F632

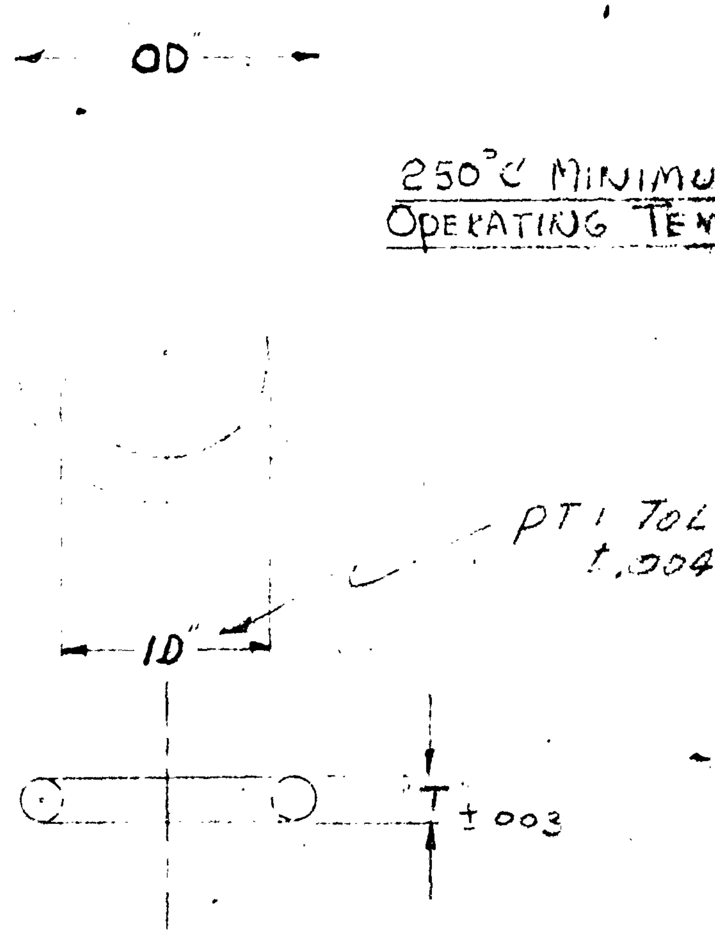
VA-8444

REVISIONS	MALLORY Main Office: Indianapolis, Ind., U.S.A.	DRAWN BY: LGKO. DATE: 3-27-58	TITLE: "O" RING	70-02688
3-7-58 L.G. ESR 70-4370	SCALE:	APPR. / DIST.		UNLESS OTHERWISE SPECIFIED DE[CI]MALS ± .005—FRACTIONS ± 1/ DO NOT SCALE - ALL DIMENSIONS INCHES DIMENSIONS BEFORE PLAT[ING]

ADD PT 3 & 4 FOR 3/4 COMM
WOW 11-28-58
ESR 70-5447

PART	ITEM	QUAN.	"T"	"OD"	"I.D."	MATERIAL - DESCRIPTION	PARKER #	FINISH	WT.
1			.040	.150	.070	PARKER-COMPOUND 76-128	5-051	*	
2			.070	.379	.239	" " "	2-10	*	
3			.040	.150	.070	" " 37-043	5-051	*	
4			.070	.379	.239	" " 37-043	2-10	*	

250°C MINIMUM.
OPERATING TEMP.



* PURCHASE

MAY BE PURCHASED FROM
PARKER APPLIANCE CO.

FOR:

F-386—Rev.—3-54

DIA. DUETL .200 VA - 847

REVISIONS
ESN 70-4370 WTA 5-6-58
2/ REACTIVATED FOR PRODUCTION WON 6-18-58 ECN 70-4601
3/ ADDED CODE, WEIGHT, & NOTES ITEMS 5, 2 GEO. 7-21-58 ECN-70-4685.
4/ ADD PT 2 FOR 3/4 COMM WON 11-28-58 ESR70-5447
5/ ADD PT 3 FOR MAGNETIC CON. WON 3-23-59 ESR70-[illegible]
6/ ADD PT 4 [illegible] 3/4 WW CLASS QSG [illegible]

MALLORY

DRAWN BY: L. [illegible] DATE: 3/4/[illegible]

SCALE: [illegible] APPR. DIST.

TITLE: "C" RING

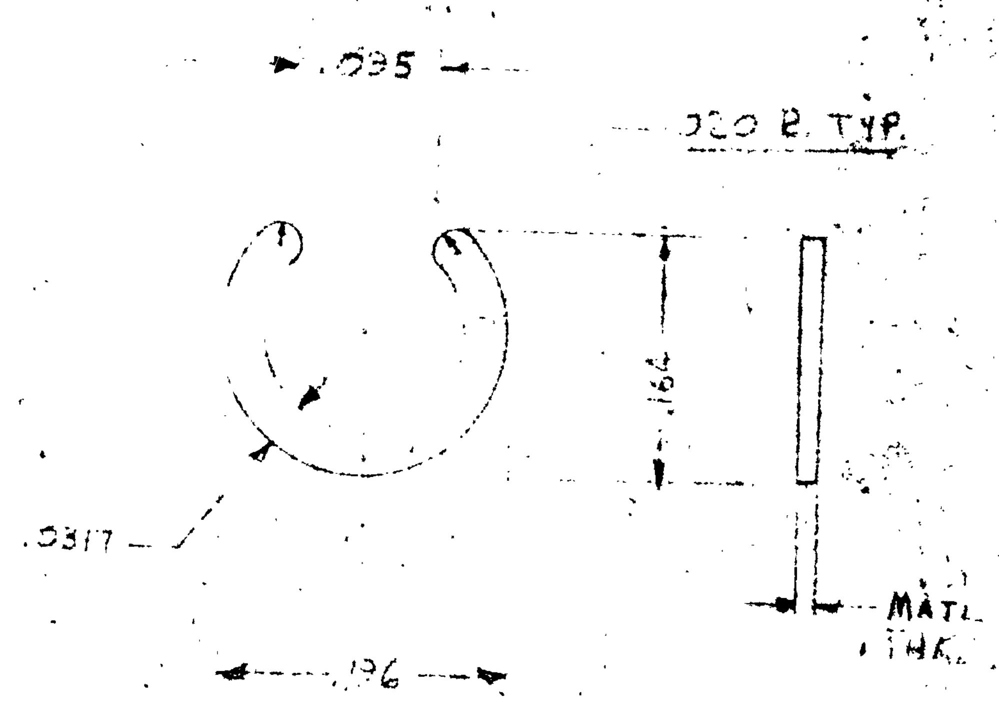
70-0268

UNLESS OTHERWISE SPECIFIED ... DECIMALS ± .005 — FRACTIONS ... DO NOT SCALE - ALL DIMENSIONS ... INCHES DIMENSIONS BEFORE PLA...

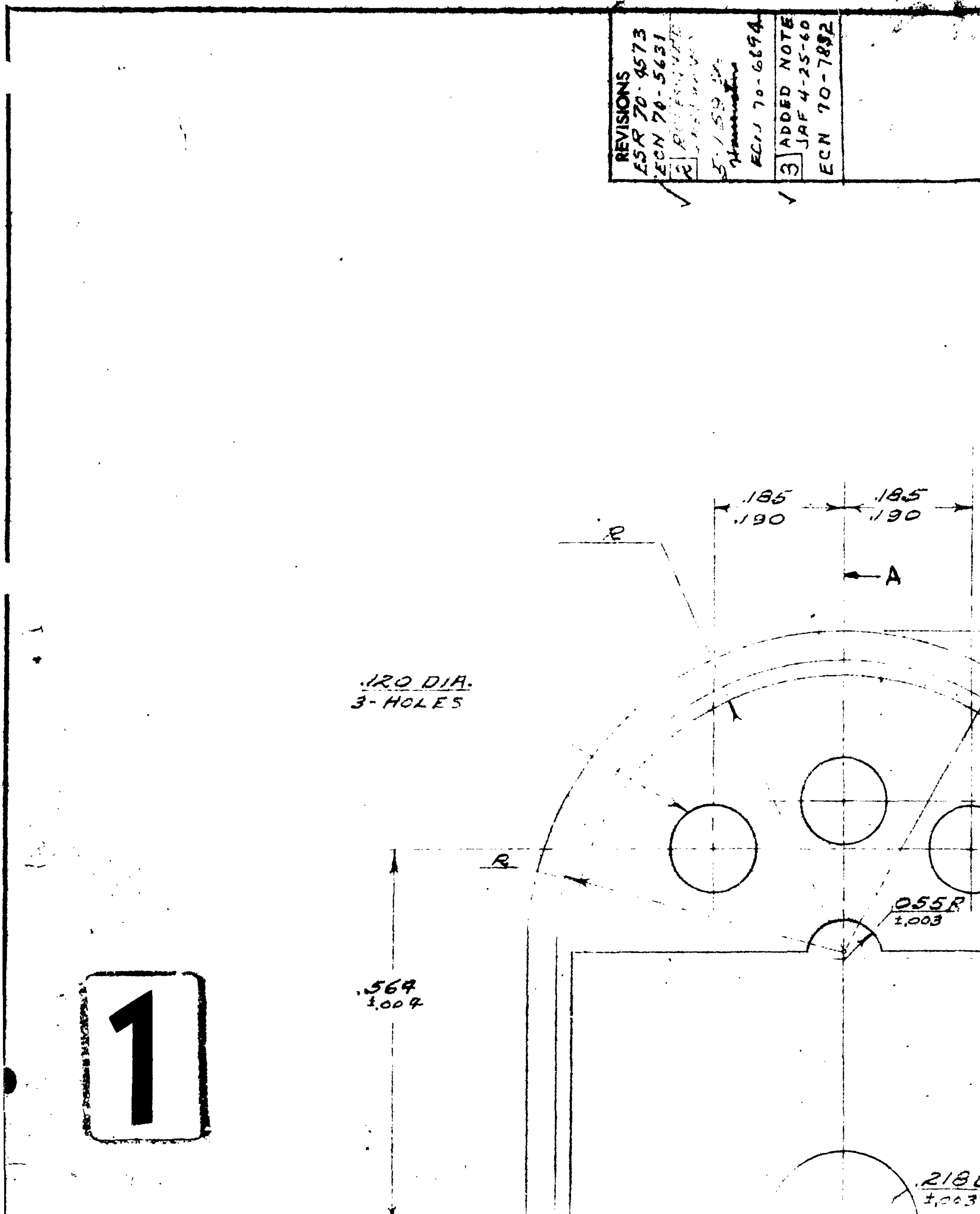
PART	ITEM	QUAN.	MATERIAL - DESCRIPTION	CODE	FINISH	W...
1			[illegible] SS. TYPE 302 [illegible]	625[illegible]	NOTE 2	.5
2			.032 THK. C.R. STEEL	63424	22	.5
3			.020 THK. C.R. STEEL	64212	22	.3
4			.032 THK. C.R. STEEL	63424	240	.5

△ FINISH NOTES

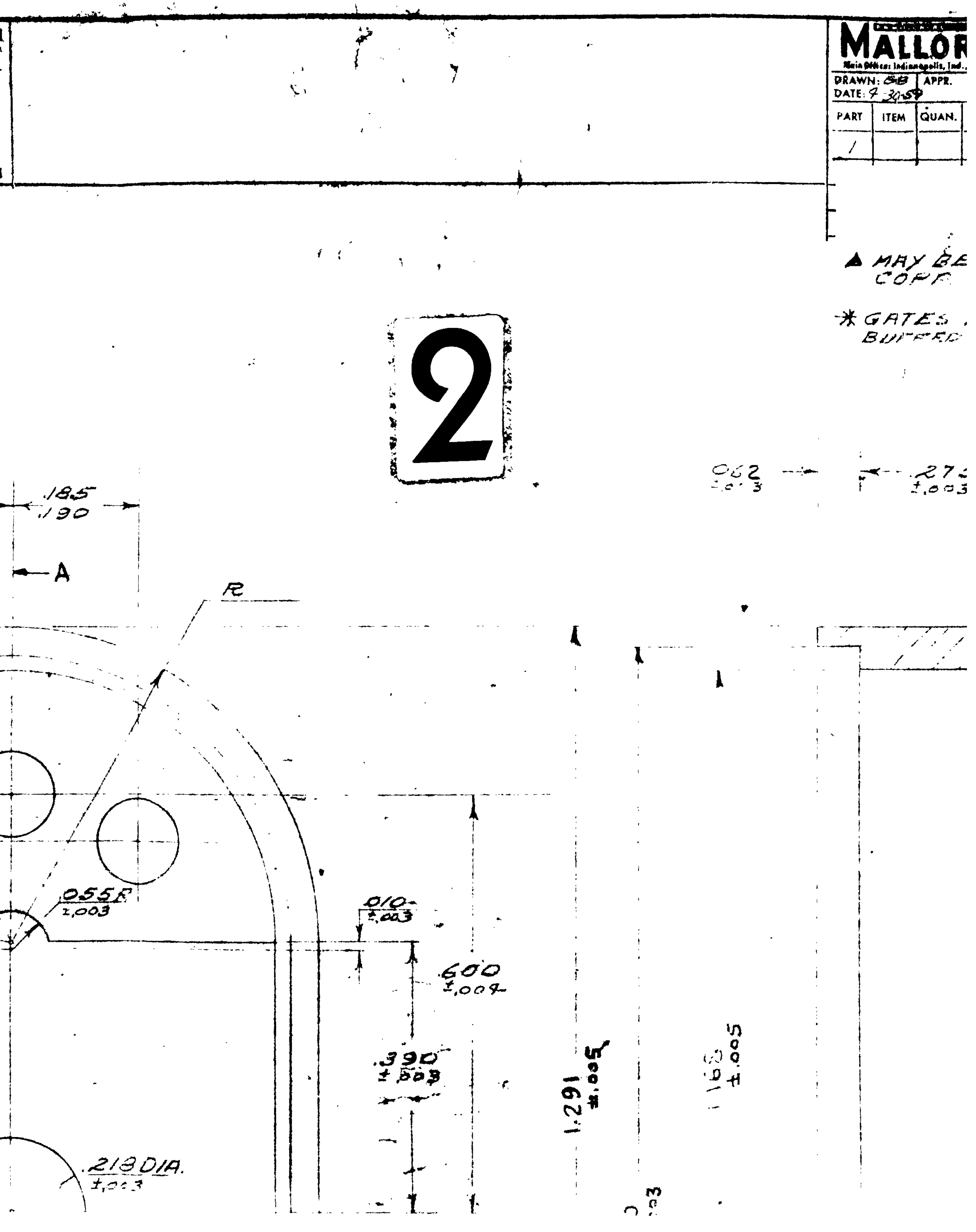
1- ANNEAL AT 1800-2100 [illegible] [illegible]H.
2- TUMBLE APPROX. 40 HRS., [illegible] CARBIDE # 80 GRIT
3- TUMBLE IN HOT CYANIDE [illegible] MIN.
4- TUMBLE IN SOAP [illegible] 1½ [illegible] MIN.
5- PASSIVATE PER [illegible]



FOR: 3/4" W.R.U.


REVISIONS
ESR 70-4573
ECN 70-5631
ECN 70-6694
3 ADDED NOTE
JAF 4-25-60
ECN 70-7832
.185
.190
R
A
.120 DIA.
3-HOLES
R
.055R
±.003
.564
±.004
.218D
±.003
1

2


MALLOR
Main Office: Indianapolis, Ind.
DRAWN: GB
APPR.
DATE: 9-30-59
PART
ITEM
QUAN.
1
▲ MAY BE
COPP
✱ GATES
BUFFED
.062
.27
±.003
.185
.190
A
R
.055R
±.003
.010
±.003
.600
±.004
.390
±.003
1.291
±.005
±.005
.218 DIA.
±.003

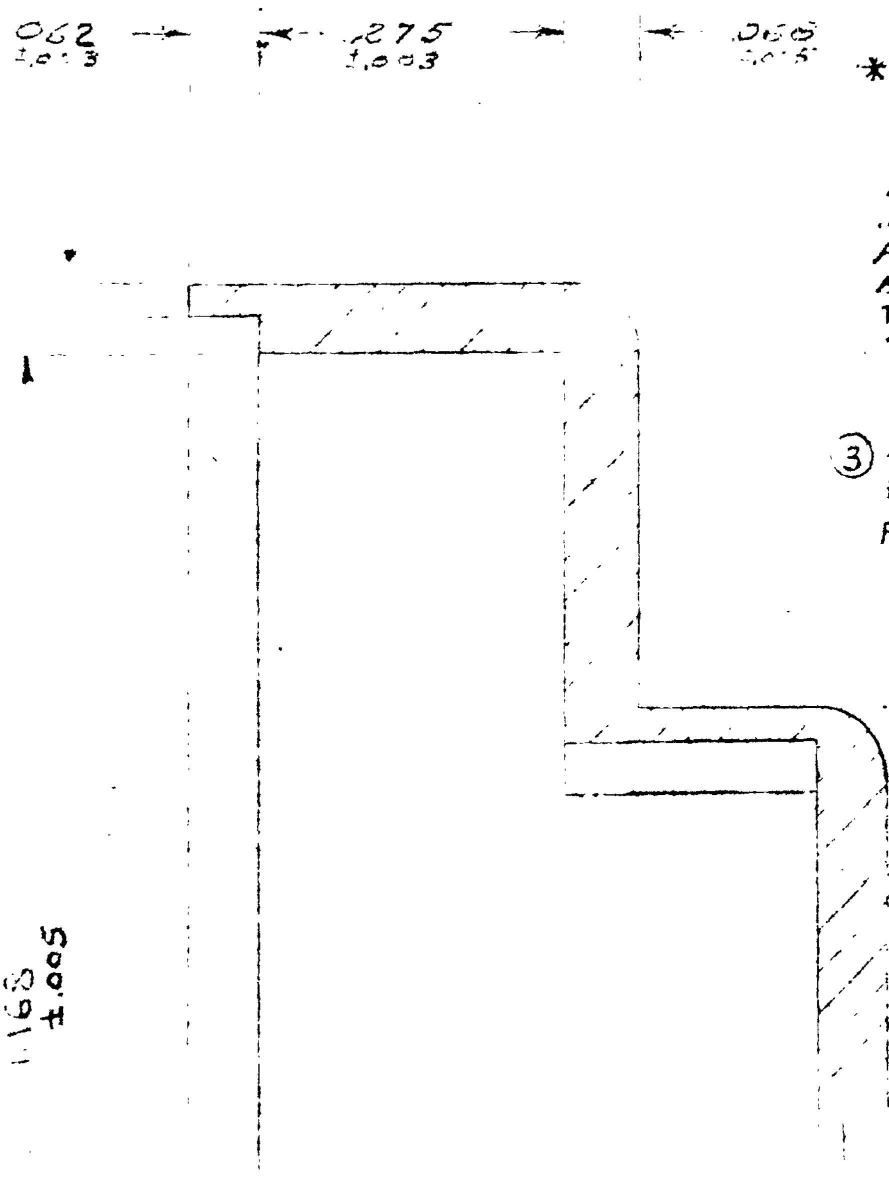
V 9664

MALLORY Main Office: Indianapolis, Ind., U.S.A.	SCALE: 5X	TITLE: CAN 10 Pinch control	90-02459
DRAWN: GB APPR. DATE: 9-30-59	DIST.		DIVISION DO NOT SCALE · ALL DIMENSIONS IN INCHES · DIMENSIONS BEFORE PLATING

PART	ITEM	QUAN.	MATERIAL · DESCRIPTION	CODE	FINISH	WT.
1			BRASS	▲	✱	

▲ MAY BE PURCHASED FROM ARWOOD SA[illegible] CORP

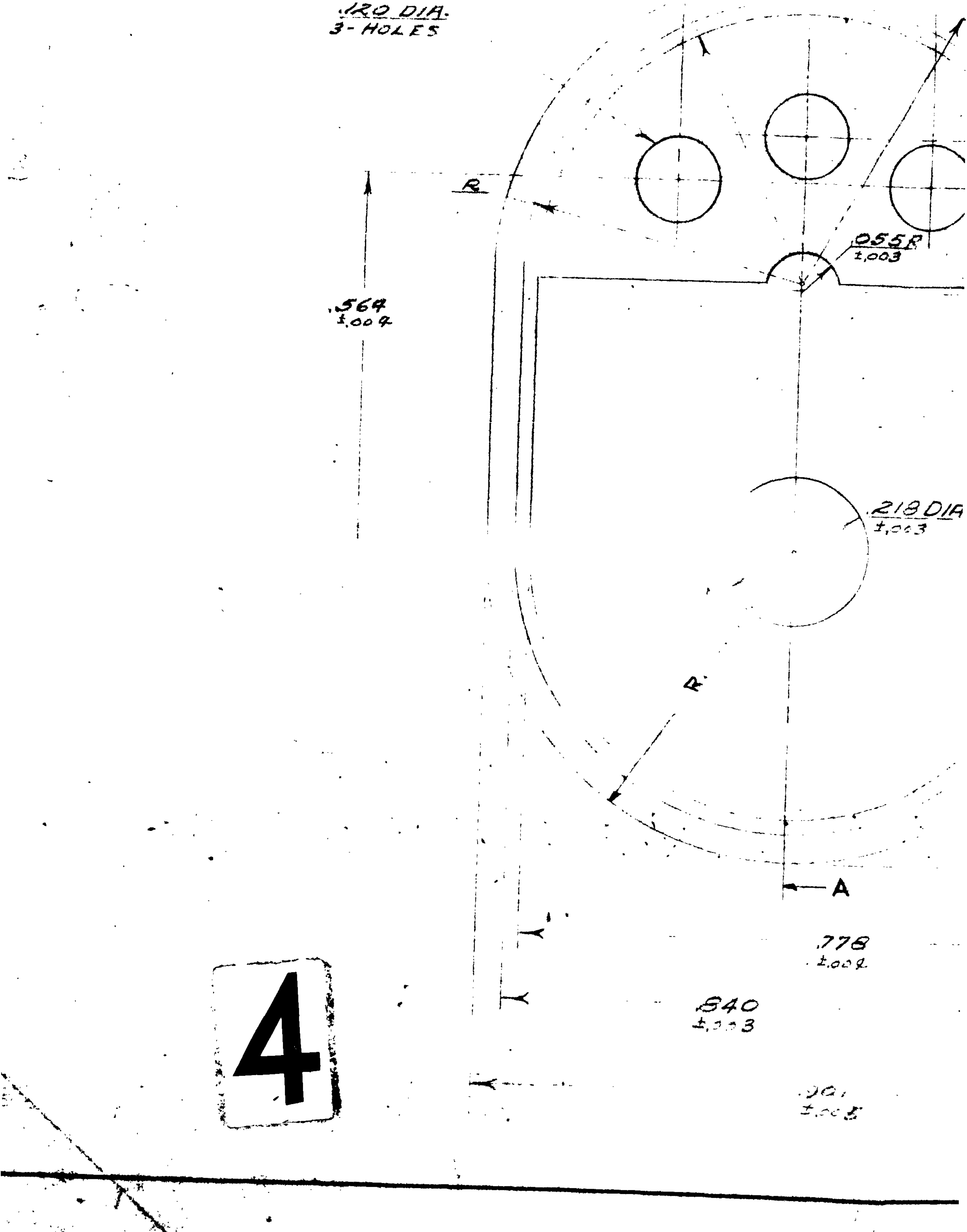
✱ GATES MUST BE REMOVED & OUTSIDE [illegible] BUFFED TO A SMOOTH FINISH BEFORE PLATING

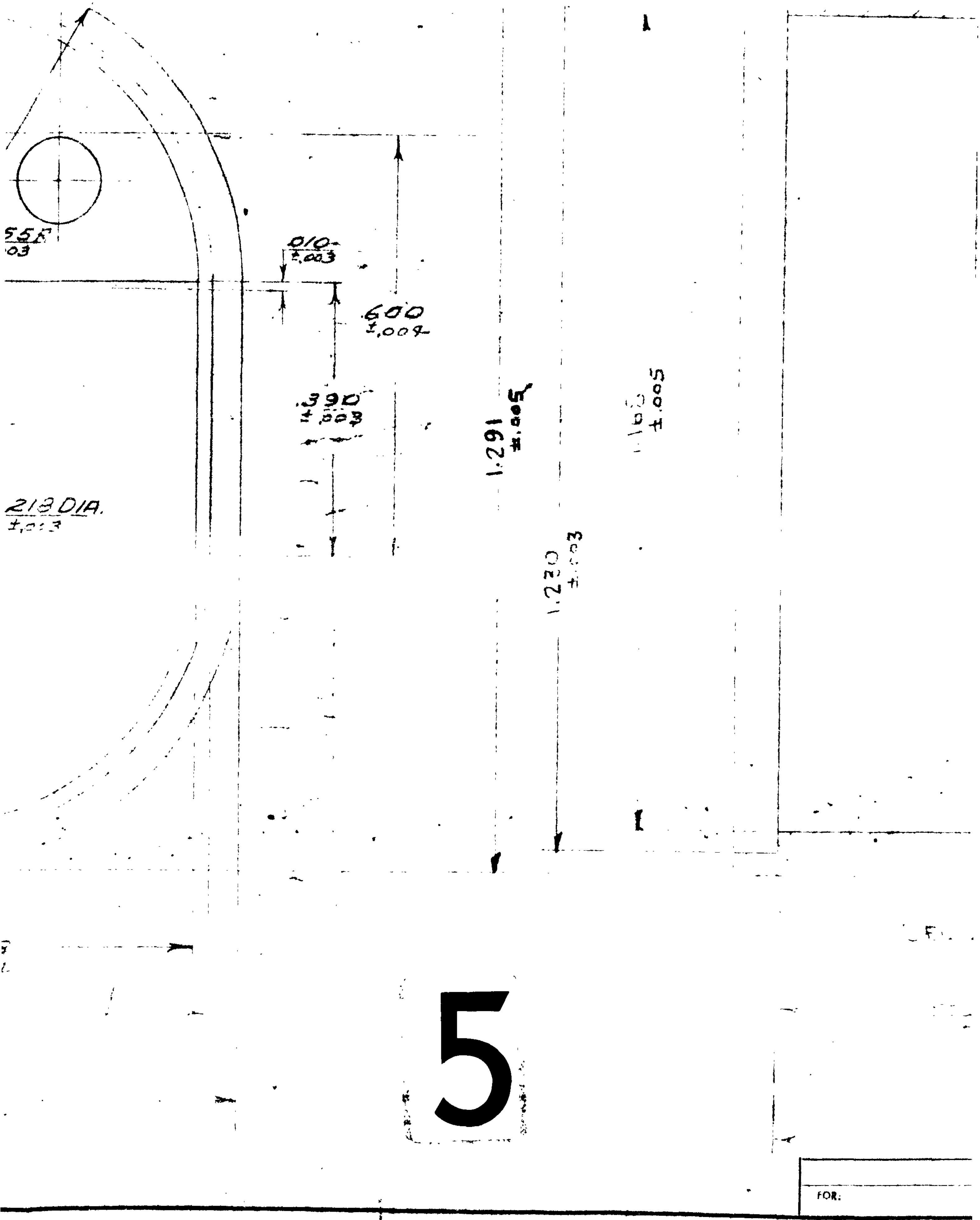


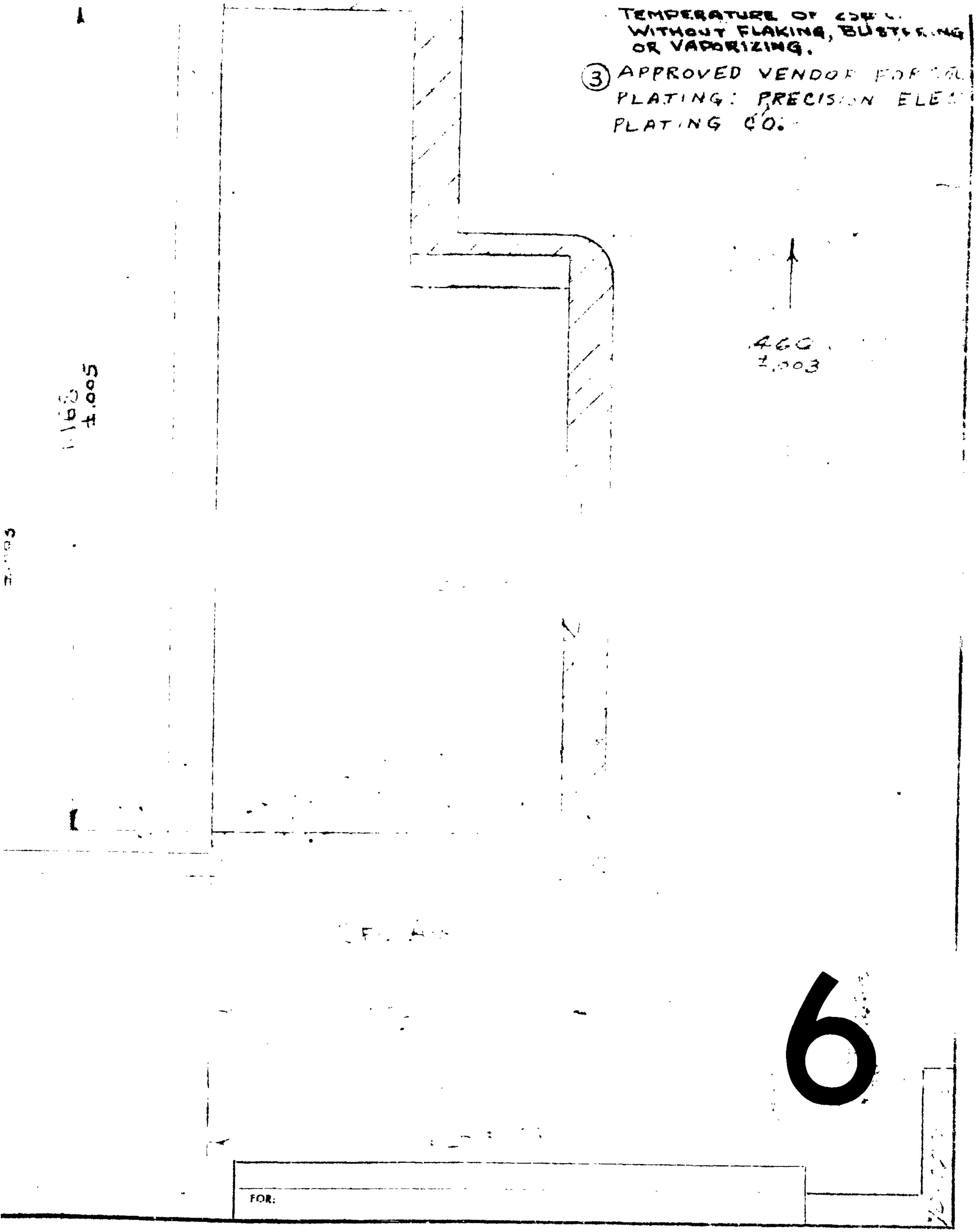
✱ PLATING SPECIFICATION.
CATHODIC CLEAN 1-MIN.
FLUOROBORIC ACID DIP
1/2 MIN. COPPER FLASH
.0001 NICKEL PLATE
.0003. BUFF TO HIGH
POLISH. CLEAN (STEPS [illegible]
ACID GOLD PLATE .0001
PLATING MUST WITHSTAND A
TEMPERATURE OF 250°C.
WITHOUT FLAKING, BLISTERING
OR VAPORIZING.

(3) APPROVED VENDOR FOR GOLD
PLATING: PRECISION ELECTRO
PLATING CO.

3


.120 DIA.
3-HOLES
R
.564
±.004
.055R
±.003
.218 DIA
±.003
R
A
.778
±.004
.840
±.003
4


.010
±.003
.600
±.004
.390
±.003
1.291
±.005
1.220
±.003
±.005
.218 DIA.
FOR:



TEMPERATURE OF
WITHOUT FLAKING, BLISTERING
OR VAPORIZING.
3 APPROVED VENDOR FOR
PLATING: PRECISION ELE
PLATING CO.
.466
±.003
±.005
FOR:
6

REVISIONS

ADDED NOTE

JAF 4-25-60

ECN 10-7832

A MAY BE PURCHASED FROM ARWOOD CA

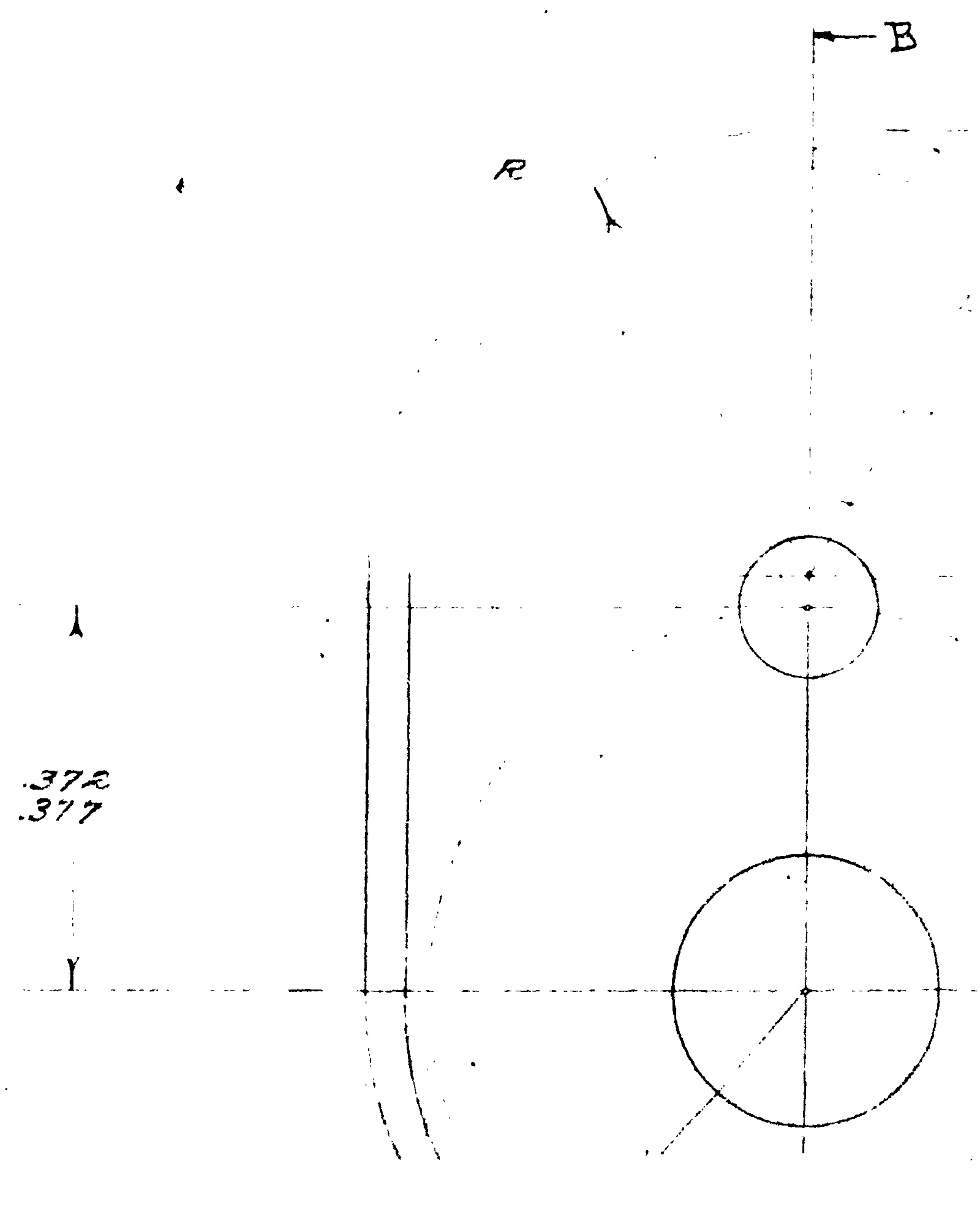
* GATES MUST BE REMOVED & OUTSIDE SURFAC
A SMOOTH FINISH BEFORE PLATING

PLATING SPECIFICATION

CATHODIC CLEAN 1-MIN. FLUOROBORIC
COPPER FLASH .0001, NICKEL PLATE .C
BUFF TO HIGH POLISH. CLEAN (STEPS 1-2
ACID GOLD PLATE .0001 - PLATING MUST
TEMPERATURE OF 250°C WITHOUT FLAKING, BLIST

3) APPROVED VENDOR FOR GOLD PLATING: PRE

1



MALLORY	
Main Office: Indianapolis, Ind., U.S.A.	
DRAWN: [illegible] DATE: 5-1-55	APPR.

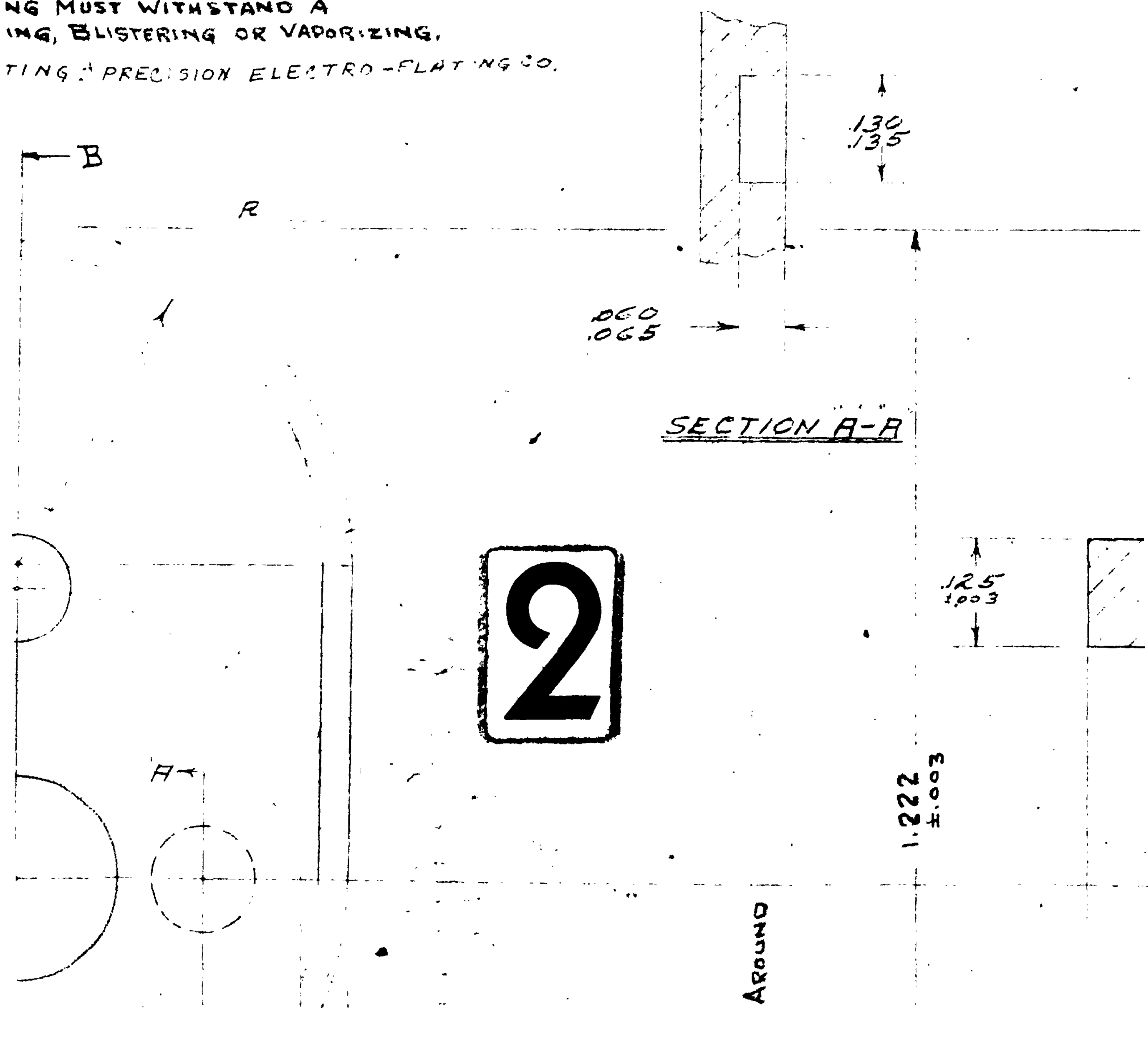
PART	ITEM	QUAN.
1		

'WOOD CASTING CORP.

E SURFACES BUFFED TO
NG

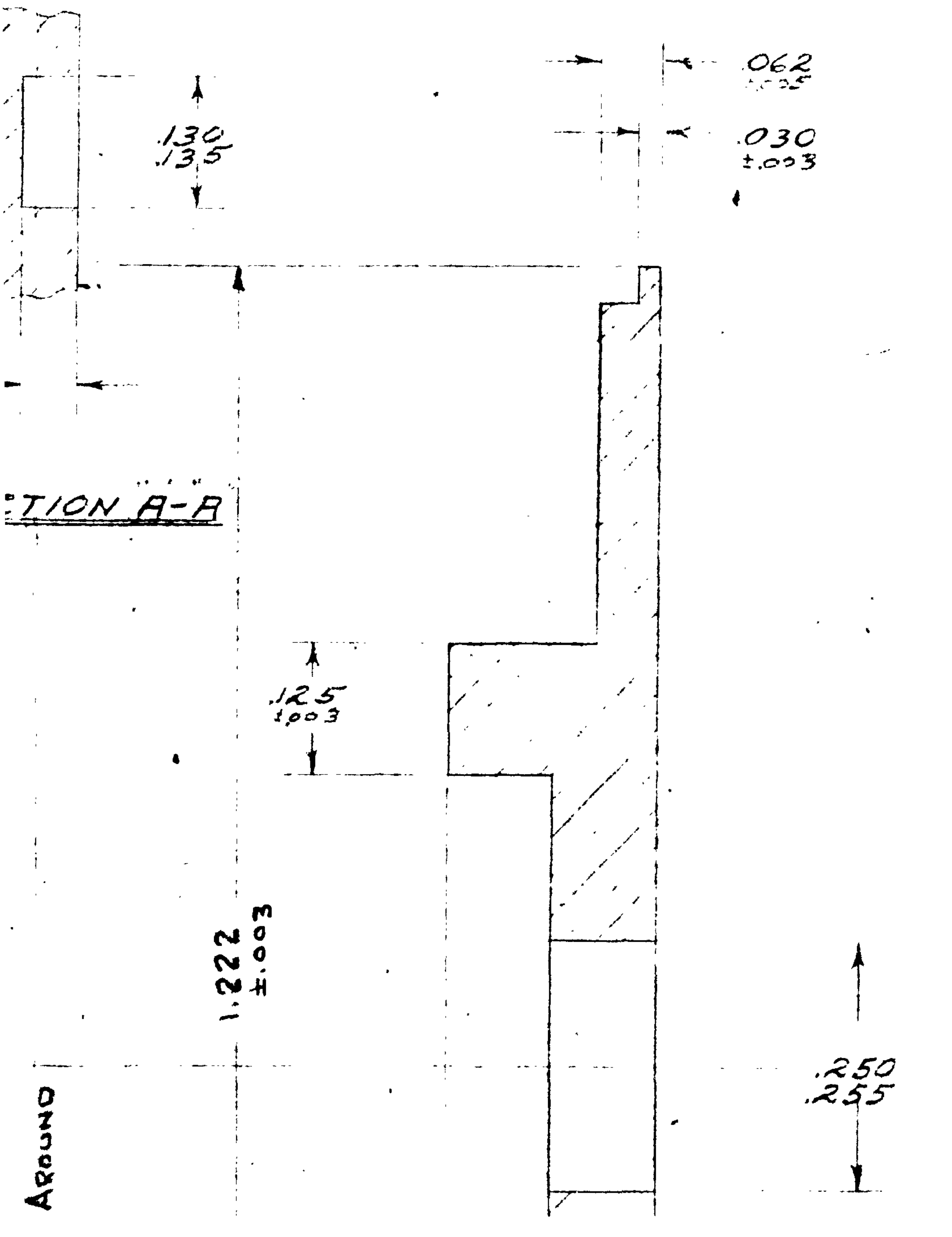
OBORIC ACID DIP 1/2 MIN.
PLATE .0003
TEPS 1-2)
NG MUST WITHSTAND A
ING, BLISTERING OR VAPORIZING.

TING - PRECISION ELECTRO-PLATING CO.

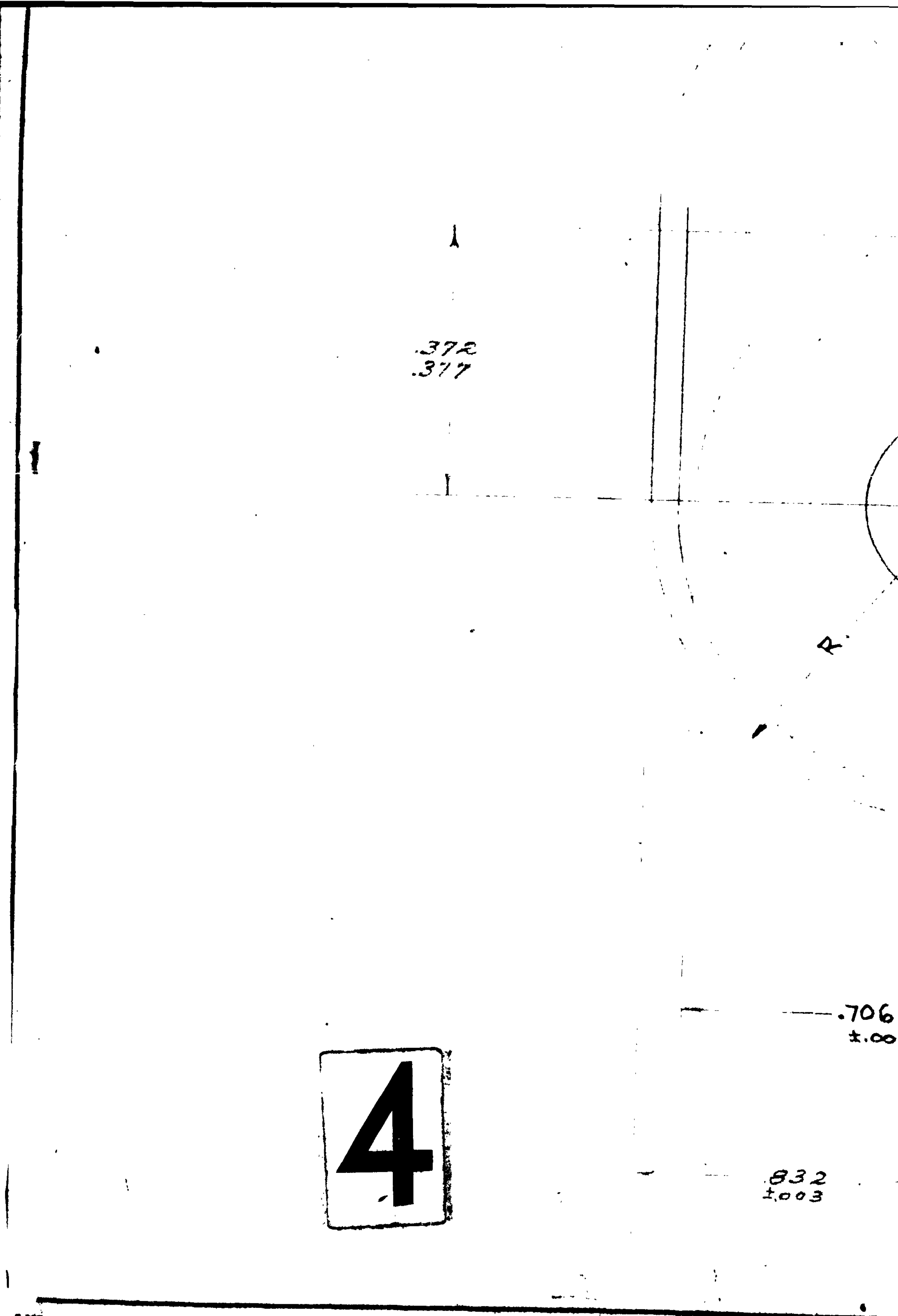


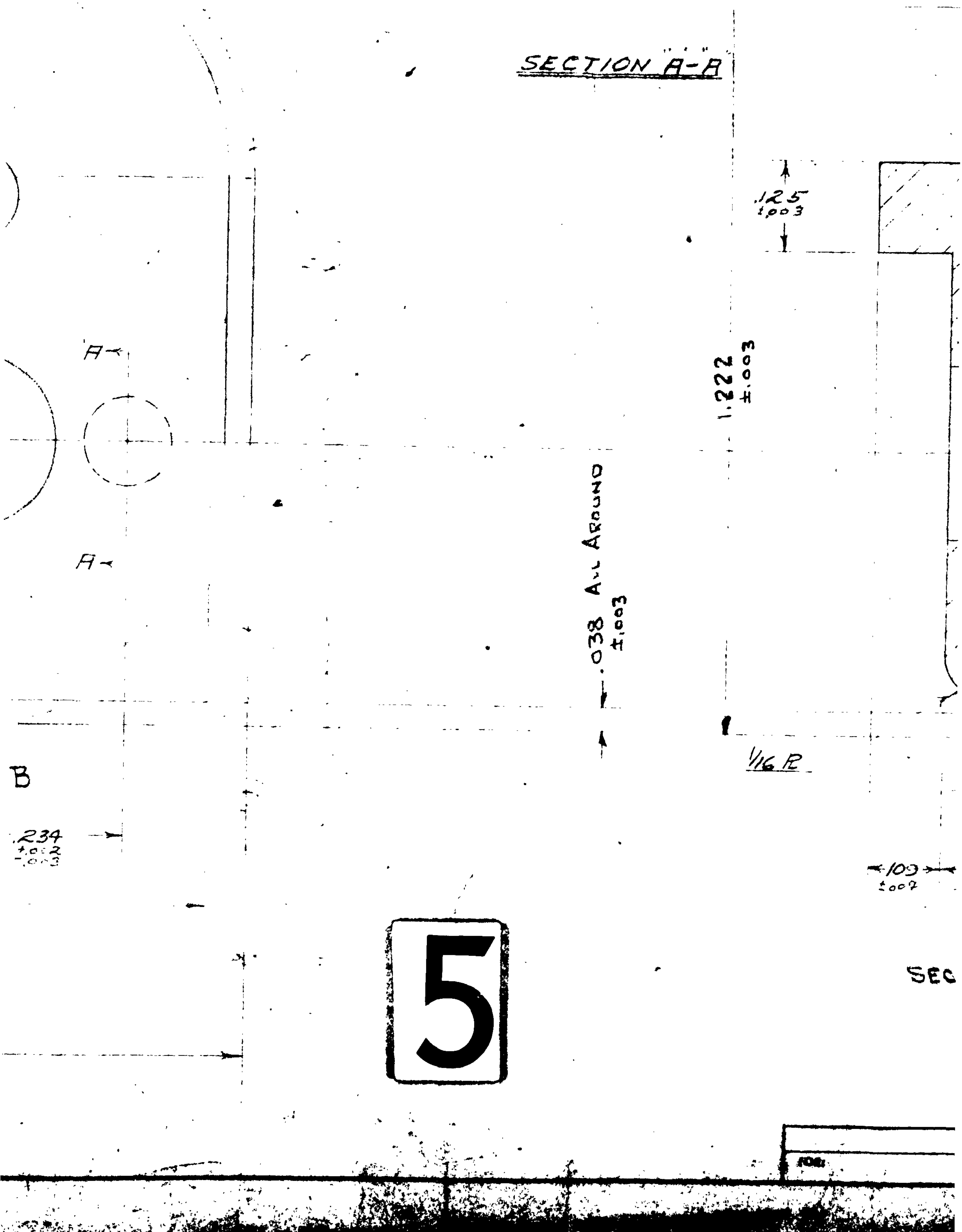
MALLORY Main Office Indianapolis, Ind., U.S.A.	SCALE: 6X	TITLE: COVER for 3/4 inch control	70-02787
DRAWN: CJ APPR. DATE: 5-1-55	DIST.		DO NOT SCALE ... INCHES

PART	ITEM	QUAN.	MATERIAL - DESCRIPTION	CODE	FINISH	
1			BRASS	▲	*	–

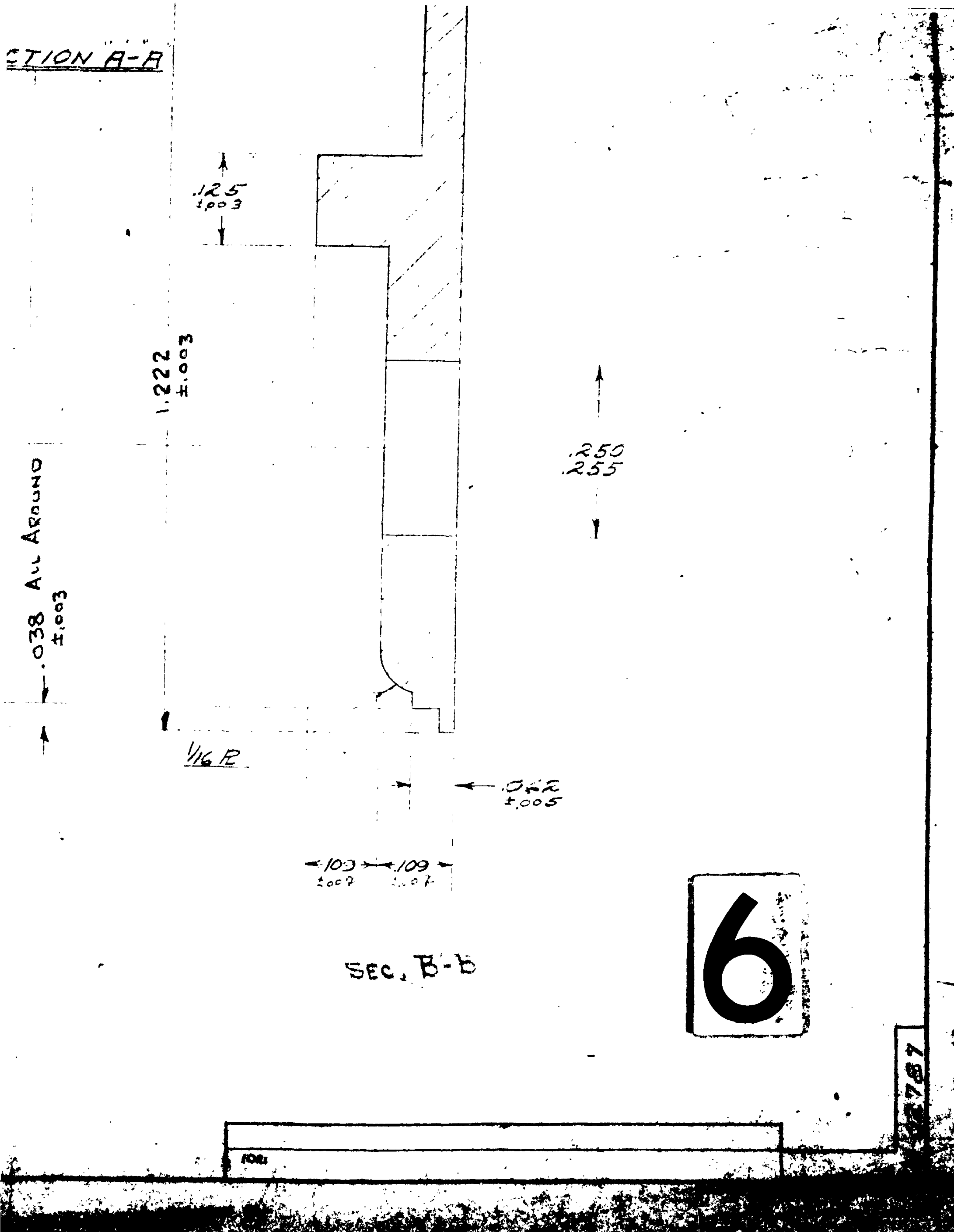


3


.372
.377
R
.706
±.001
4
.832
±.003



SECTION A-A
.125
±.003
1.222
±.003
.038 ALL AROUND
±.003
1/16 R
A
A
B
.234
+.002
-.003
.109
±.002
5
SEC


TION A-A
.125
±.003
1.222
±.003
.038 ALL AROUND
±.003
.250
.255
1/16 R
.042
±.005
.103
±.007
.109
±.007
SEC. B-B
6

VA - 8441

REVISIONS

1 — PT 6 WAS HOT SOLDER DIP RM 7-1-59 ... -6671

— PT. 6 'A' DIM. WAS 1/8". JLK 9-21-59

MALLORY
Main Office: Indianapolis, Ind., U.S.A.

DRAWN BY: L.GEO.
DATE: 3-25-58

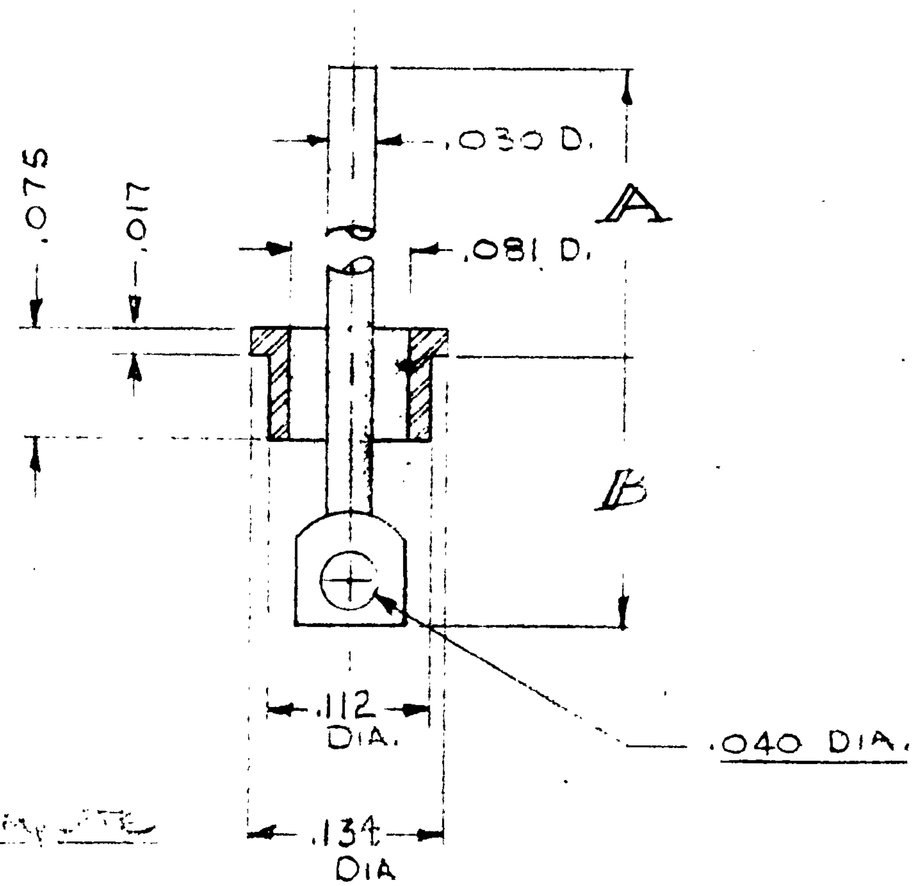
SCALE: 8 X
APPR.
DIST.

TITLE: TERMINAL HERMETICALLY SEALED

70-02786

UNLESS OTHERWISE SPECIFIED D... MALS ± .005 — FRACTIONS ± 1... DO NOT SCALE – ALL DIMENSION... INCHES DIMENSIONS BEFORE PLA...

PART	ITEM	QUAN.	A	B	MATERIAL - DESCRIPTION	CODE	FINISH	W
1	STD.		25/64	13/64	GLASS SEALED	HOT SOLDER DIP		
2	A		1 1/16	11/64	"	"	"	"
3	B		17/32	11/64	"	"	"	"
4	C		7/8	13/64	" "	"	"	"
5	D		11/16	9/16	"	"	"	
6	E		11/64	17/64	"	GOLD PLATE		



* PURCHASE COMPLETE

ENGR. REF. ELECTRICAL INDUSTRIES #4AS-30W-SP

FOR:

F-386—Rev.-3-54

REVISIONS
0/ ESR-70-4461 L.G. 5-21-58
1 ADD PT 2 FOR ELECTRONICS W 12-2-58 SR 70-5457
2 ADD PT 3 FOR 70-14[illegible] W.O.N 2-17-61 ESR 70-9[illegible]
3 ADD PT 4 FOR 70-06288 [illegible]

MALLORY
Main Office: Indianapolis, Ind., U.S.A.

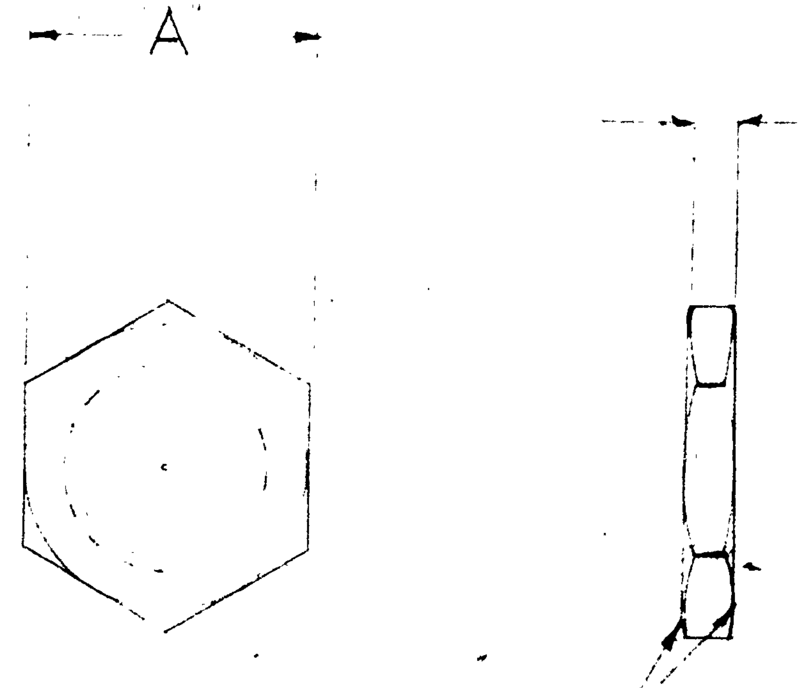
DRAWN BY: L.GEO
DATE: 5-2-58
SCALE: 4X
APPR.
DIST. 91

TITLE: MOUNTING NUT.

7[illegible]

UNLESS [illegible] MALS ± [illegible] DO NOT [illegible] INCHES [illegible]

PART	ITEM	"A" DIM.	THREAD	MATERIAL - DESCRIPTION	CODE
1		5/16	1/4X32-NEF2B	5/16 HEX. H.H. BRASS ROD	6231[illegible]
2		5/16	1/4X32-NEF2B	5/16 HEX. H.H. BRASS ROD	6231
3		5/16	1/4X32-NEF2B	5/16 HEX STEEL ROD	PURCH.
4		5/16	1/4X32 NEF 2B	5/16 HEX [illegible]	6231



* 63 FINISH
NICKEL-.0002"-.0003" THK.

CHAMFER BOTH SIDES

FOR: SS CONTROL (3/4")

F-386—Rev.--3-54

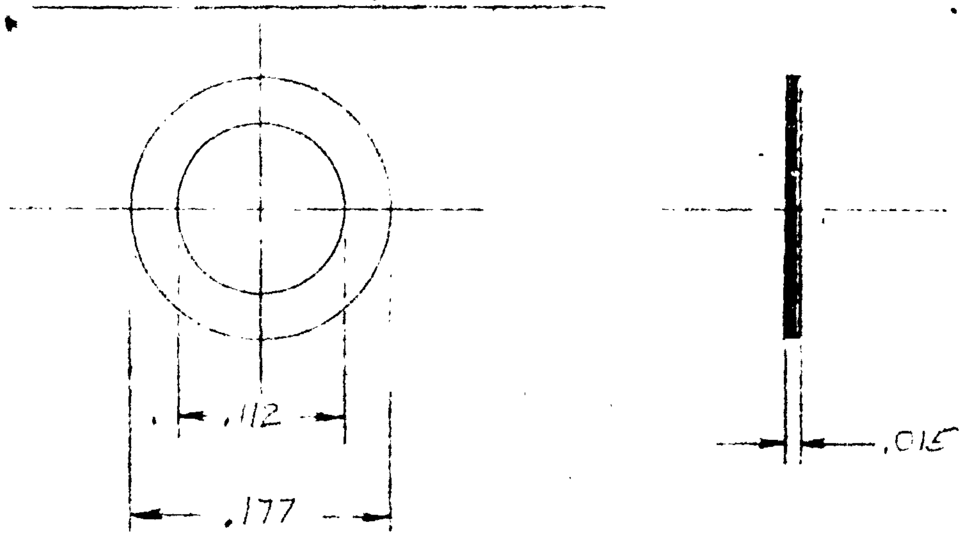
REVISIONS
ECR 70-4573
1 ADD WASHER NOTE WGN 6-18-58
ECN 70-4601

MALLORY Main Offices: Indianapolis, Ind., U.S.A.	DRAWN BY: W.H. DATE: 6-12-58	TITLE: SOLDER RING FOR 3/4 INCH CONTROL	70-02793
SCALE: 4X APPR.	DIST.		UNLESS OTHERWISE SPECIFIED DECIMALS ± .005—FRACTIONS ± 1/6[illegible] DO NOT SCALE - ALL DIMENSIONS INCHES DIMENSIONS BEFORE PLATI[illegible]

PART	ITEM	QUAN.	MATERIAL - DESCRIPTION	CODE	FINISH	WT/[illegible]
1			2.5% SILVER 97.5% LEAD	*		

* PURCHASED FROM KESTER SOLDER CO., CHICAGO, ILL

NOTE:
WASHER RESIN-FINE #66 CORE



FOR:

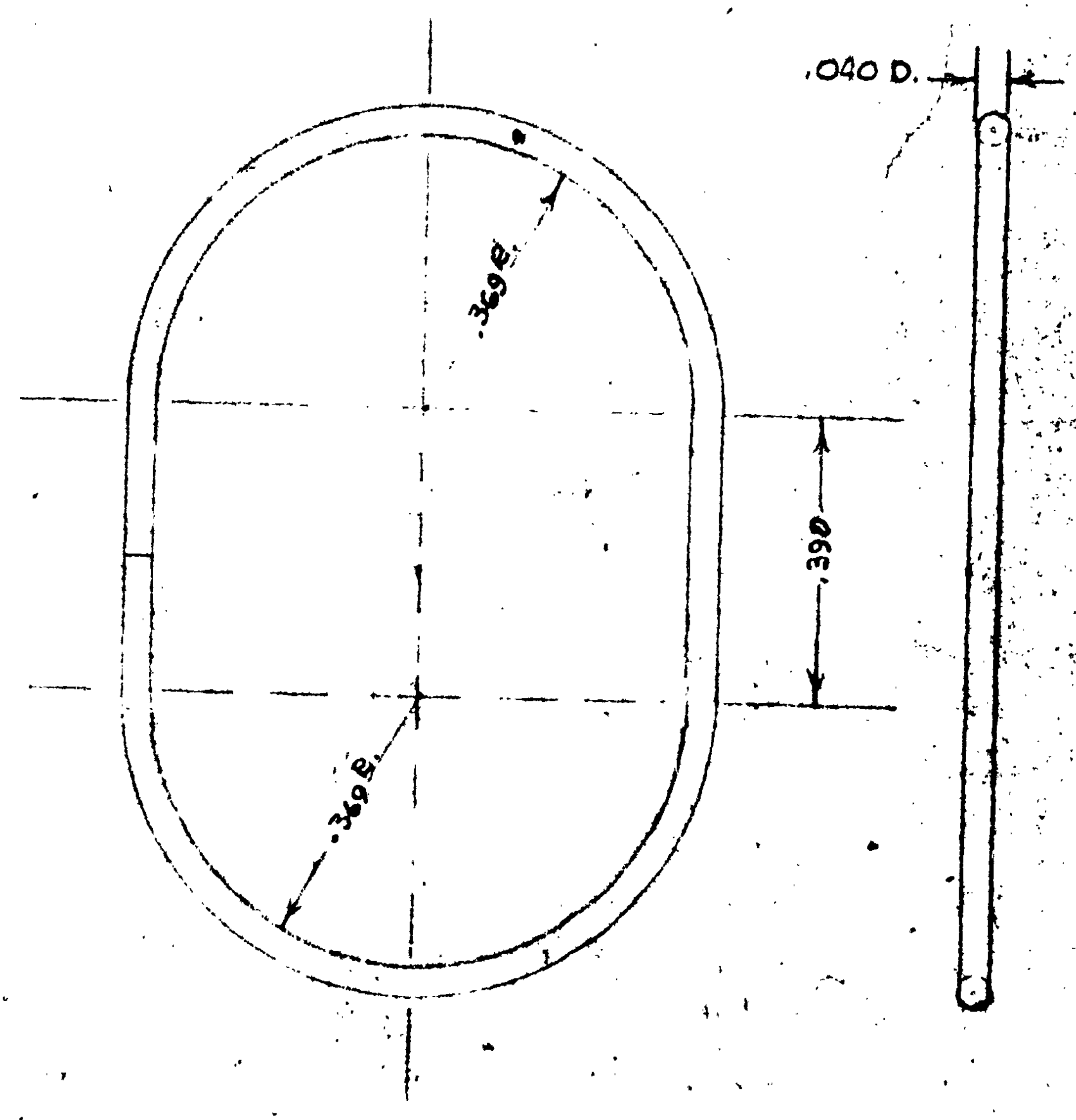
F-386—Rev.--3-54

REVISIONS
ESR 70-5252
LG, 10-29-58,

MALLORY	DRAWN BY:	TITLE:	70-0306B
	DATE: 10-29-58	SOLDER RING FOR S.S. CONTROL	UNLESS OTHERWISE SPECIFIED ... DO NOT SCALE - ALL DIMENSIONS ...
SCALE: 4X	APP'D. LG.	DIST.	

PART	ITEM	QUAN.	MATERIAL - DESCRIPTION	CODE	OWNER	WT.
1			.040 WIRE 2.6% SILVER 97.5% LEAD	#66 Resin 5	*	

* PURCHASE FROM HESTER - CHICAGO, ILLINOIS



FOR: 70-02729 HERMETICALLY SEALED S.S. CON.

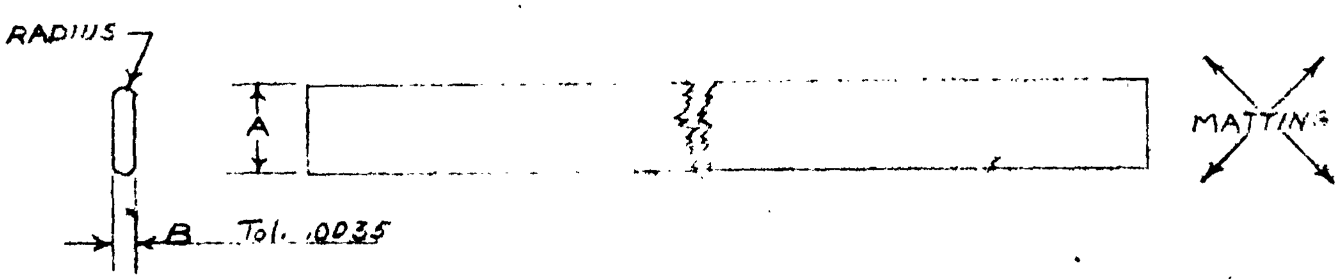
70-0306B

VA8401

REVISIONS	MALLORY Main Office: Indianapolis, Ind., U.S.A.	SCALE: 4	TITLE: CORE STRIP for 3/4" WIRE WOUND	70-02812
ECN 70-4601	DRAWN: L.S.K. APPR.	DIST. 92		DIVISI
1 Added 'B' dim. tolerance. L.G. 8-26-58. ECN 70-4905	DATE: 2-14-55			DO NOT SCALE - ALL DIMENSIONS INCHES - DIMENSIONS BEFORE PLAT
2 ADD PT 2 FOR 3/4 COMM WON 11-28-58 ESR 70-5947				

PT NO	A	B	RAD	MATERIAL - DESCRIPTION	CODE	MIN. STRL. LENG.	WT.
1	.248 .252	.030	.016	.030 SILICONE GLASS	*	9"	
2	.248 .252	.030	.016	.030 FLEXIBLE - PHENOLIC		36"	

* NOTE! MATERIAL MUST BE FABRICATED WITH MATTING AT 45° TO FACILITATE FORMING. MUST WITHSTAND CONTINUOUS OPERATION AT 250°C. e.g. MICA INSULATOR G-7 No. 6110



FOR: